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SCIENCE AND MATHEMATICS IN VOCATIONAL SCHOOLS: A RETROSPECT.

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To be invited to address the Central Association is a great honor; for me to speak before the Association in this city, on any phase of present day American education is a precarious undertaking, for many of you are national leaders, and Des Moines is the seat of five universities and colleges. I consider it, therefore, the better part of valor to take refuge into the past and translate myself to foreign lands.

Vocational schools are not of recent origin. The oldest vocational institution in America was Harvard College, founded in 1636 as a place for the training of young men for the ministry. Schools preparing for the Bristish Navy existed at the time of Sir Isaac Newton, whose advice was sought as to the best courses to be offered.[2] Vocational training goes back as far as Greek antiquity.[3] To write the history of vocational institutions would be to fill ponderous volumes. In recent years a new type of vocational school has sprung into existence, as the result of the rapid progress of science, the new industrial, social and economic conditions. The disappearance of the old system of apprenticeship, the introduction of the factory, the intense struggle for industrial supremacy, the growth of the cities, the greater laxity of home discipline, have thrust new responsibilities and burdens upon the state and the school for the training of youths during the early adolescent period. It is of these recent movements, as originated in Europe, that I desire more particularly to speak on this occasion.

In America a boy has been permitted by the state, and very often by his parents, to leave school at the age of 14, and to map out his own course of life, in spite of his ignorance of life and his

[1] Read before the Central Association of Science and Mathematics Teachers at Des Moines, Iowa, Friday, November 28, 1913.
[2] J. Edleston, *Correspondence of Sir Isaac Newton and Professor Cotes.* London, 1850, pp. 279-297.
[3] L. F. Anderson, *School Review*, Vol. 20, 1912, pp. 191-201.

inefficiency as a workman. Such a boy is in danger of becoming a recruit in the army of the unemployed, and to become a menace to society. Have the parents and the state done thei rduty? No. Such a boy is like a horse harnessed to a wagon and left unhitched in the street when the railroad train rushes by. The horse does not want to run away, yet cannot help it. If capable of utterance it would say, "Somebody please stop me, please hold me." He feels the need of superior guidance. He must feel the bit now and then. And so the state should step in and say, "Boy of fourteen, you must either go to a high school, or if you go to work you must attend a continuation school to learn your trade and to prepare for good citizenship."

The first effective solution of the problem of guiding and restricting young boys and girls was given in Germany. The Germans have fully recognized the importance of employing the period of adolescence for consolidating and fixing permanently the knowledge acquired during childhood, and of training efficient and intelligent workmen. The continuation school does this for some boys and girls. For others who wish to continue in a regular full-time school and who are not attracted by the old form of academic or classic secondary curriculum, but desire courses that are more immediately practical, there was formed the intermediate technical school, or technical high school. Munich has been in the lead in this great movement.

On January 1, 1876, obligatory continuation schools were opened in Munich for boys. At first boys between 13 and 16, who were working, were required to attend a continuation school from two to five P. M. on Wednesdays and for five hours on Sundays, the course of instruction being reading, writing, arithmetic and drawing. As the work of these schools was far from satisfactory, Schulrath Kerschensteiner matured plans of reorganization. In 1900 the schools were remodeled in accordance with the ideas set forth in Kerschensteiner's famous Prize Essay. The course of instruction was modified so as to fit the occupations of the pupils, who were classified according to their trades. In this reorganization, the vocational feature was introduced, though even then there was little attempt at practical work. This new scheme was only moderately successful. A few years later Kerschensteiner introduced further changes. By laying much greater emphasis upon practical work, he aimed to secure to a higher degree the interest and good-will of pupils and, in the end, to accomplish really more along the line of the theoretical subjects of

drawing, arithmetic and the elementary sciences. Kerschensteiner secured also the active sympathy of employers and trade associations. The employers were encouraged to visit the schools, to give advice regarding the schemes of instruction, the choice of teachers, the time of day when the pupils could best be spared by the employers. Compulsory attendance on Sundays and evenings was done away with. The last touches in the scheme of reorganization were effected in 1910. As now constituted, the courses of study, though severely practical, pay attention to the training of citizenship. Lebens-und Buergerkunde are taught in every continuation and trade school in Munich.

These new schools have led to new problems. Attended by pupils of less maturity than those of the higher technical schools, new courses of study and modified modes of teaching were called for. The psychologic side demanded careful consideration. Eager to get at what is immediately practical, and fretting under the task of learning that which seems to them of no value, they must be led to see the motive of every step in their training. Much experimentation has been and is still in process as to the best mode of conducting such schools. What subjects should be taught, and how? What branches of science and mathematics should be taken up, and in what way can the instruction be made most effective?

The psychological necessity of keeping all work in science and mathematics in constant touch with practical problems, the necessity of avoiding, in fact, all theoretical instruction except when forced upon the pupil and teacher by the demands of a practical problem, makes it often impossible to develop a topic in a systematic manner. The clue to the instruction must be sought in the boy's interest and aptitude, rather than in any logical arrangement of the subject matter. Moreover, students in electrical work may encounter wholly different problems from students in plumbing. These considerations, combined with difficulties arising from the lack of uniformity in preparation, and the immaturity of the pupil, give point to a remark made in an Austrian report[4] to the effect that the "instruction in trade schools makes indeed the greatest demands upon the individuality of the teacher." The problem of securing properly prepared teachers has been found to be a difficult one. In reply to the question—"Do you prefer to convert a tradesman into a teacher or a teacher into a tradesman?"—Dr. Kerschensteiner declared unhesitatingly in

[4] *Bericht über den Mathematischen Unterricht in Oesterreich.* Heft 4, Wien, 1910, p. 40.

favor of the former course.[5] However, such instructors have usually attended courses in the art of teaching. As a rule compelled to proceed without the use of a text-book, the teacher's power of adaptability to various exigencies that may arise is taxed to a degree as nowhere else. Nowhere is the demand so imperative for truly great teachers, as there is in the teaching of mathematics and science in vocational schools.

Here is the general plan as given by an English teacher of practical mathematics, Mr. Sanderson of the Oundle School[6]: "An attempt is made to look upon the class as a staff of workmen, actually engaged in some 'live' work. . . . Mathematics come in incidentally and are learnt as need arises. The various mathematical principles and methods are thus acquired indirectly by continually applying them, and the boy learns his elements of mathematics in much the same way as he learns to walk. At a later stage he may put his knowledge into a logical frame-work."

Here are the words of a teacher in a building trade school in Leipzig[7]: "In our opinion, the mathematical instruction in technical schools, in order to lead to satisfactory results, must grow out of the practice and then grow into the practice."

What are some of the fundamental principles which are essential according to European experience?

First: A boy will grasp a mathematical process or a scientific law with much greater ease if it is introduced to him in connection with a practical problem.

Second: The average boy can much more readily be brought to *undertake independent thinking* when he is placed in contact with a practical problem; the average boy usually abhors abstractions.

Third: The elementary trade school should aim to develop power of technical thinking, and also to impart technical knowledge and skill. The mind of the boy is to be exercised and trained by direct contact with the concrete and practical rather than by the more formal study of mathematics and scientific law, as given in the non-trade high school.

Fourth: The contents of the instruction in a continuation or trade school must be determined by the practical need of the community and the special tastes and aptitudes of the pupil.

Proceeding to the consideration of details, we find some things

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[5] *Leith School Board. Report on Visit to Continuation and Trade Schools* in Germany, Paris and London, 1912, p. 9.

[6] *The Teaching of Mathematics in the United Kingdom.* Report No. 33, London, 1912, p. 5.

[7] G. Ehrig, *Mathematischer Unterricht an BaugewerKenschulen*, Leipzig, 1904, p. 16.

in the old country on which we ought to be able to improve, and other things which we can well afford to adopt. During the past decade a tremendous impetus has come from Germany, under the leadership of Felix Klein, of Göttingen, toward the establishment of a more perfect union between different branches of elementary mathematics—arithmetic with algebra, algebra with geometry and trigonometry—and toward more graphic work and greater stress upon functional relations. It is somewhat surprising that these radical reforms in mathematical teaching have as yet hardly reached down to the mass of elementary, German technical schools which we are considering. To be sure, geometry and drawing are quite extensively correlated, so are arithmetic and bookkeeping, particularly in Munich. But the examination of German courses of study reveals the fact that arithmetic and algebra are taken up quite independently; so are algebra and geometry. The idea of unification has not yet been practically tested in the German schools now under consideration. That a certain amount of unification is desirable, few of us would deny. That any mode of unifying mathematics is an improvement on the old method, is far from self-evident. Over-sanguine reformers may easily commit serious blunders. Fusion may mean confusion. There is room here for careful and thoughtful experimentation, to ascertain to what extent unification may be beneficially adopted. There is probably greater need of unification in elementary technical schools for the reason that in these schools mathematics are not taken up except when absolutely needed, and arithmetic, algebra, geometry and drawing are most likely needed at one and the same time in the study of some one practical trade problem. The trade school invites not only for the observance of the organic interrelation between different branches of elementary mathematics, but also for the intimate correlation of mathematics with the work of the shop. It makes a wide appeal for the exercise of self-activity on the part of the pupil. In Munich, "nothing is drawn that is not made in the workshop, and nothing is made that is not drawn." Nowhere is the appeal for the teaching of mathematics as one subject made more strongly than in England. Says one of the reports of work in evening technical schools[8]:

"The main principle is that mathematics is taught as one subject and not as many. . . . Results are only recognized when reduced to a numerical form. Every aid to obtain numerical re-

[8] *The Teaching of Mathematics in the United Kingdom.* Report No. 24, London, 1912, p. 5.

sults, or to express them clearly, is made use of. Thus the use of logarithms, the use of the slide rule, the graphical representation of results on squared paper, are all made prominent in the work, the range of which covers the elements of algebra, trigonometry, dynamics, and statics."

Germany can give us lessons in the teaching of arithmetic. In 1872 Germany adopted the metric system. The bitterness engendered by the Franco-Prussian war did not prevent the conquering Germans from adopting an improvement introduced by the French. The adoption of the metric system resulted in greater emphasis being placed on decimal fractions and less on common fractions..[9] The study of the intensely practical subject of denominate numbers is simplified enormously; the metric system is one of the greatest inventions ever made along the line of greater efficiency and mental economy. It is humiliating that England and the United States have not followed the lead of other civilized nations in relieving children of the great burden of mastering antiquated and discredited systems of measures. No one other reform can aid a boy of 14 as effectively in preparing himself for industrial life as the introduction of the metric system. Of course, there are inconveniences and expenses in making the change. So there is in moving from an old house into a new house. But where is the country which, having once adopted the metric system, has seriously considered a change back to the old one. In our judgment, the failure of the United States to introduce the metric system is due to the apathy of its scientific men and its teachers. Have we as teachers carried on an effective propaganda? No. The American Association for the Advancement of Science, the National Educational Association, the American Mathematical Society, and other scientific bodies should exert their influence by yearly petitions, repeated petitions, until the object is attained. We need the persistency of the Roman censor who, in season and out of season, came forth with the declaration: *"Delenda est Carthago*—Carthage must be destroyed."

The subject of proportion is still awaiting to be recast in German trade schools. The antiquated terms of arithmetical, geometrical and harmonic proportion have not wholly disappeared from books.[10] The treatment of proportion in Germany, as well as in the United States, is still encumbered by a clumsy notation; the quantities involved are looked upon as rigid. Proportion should

[9] W. Lietzmann, *Stoff u. Methode des Rechenunterrichts in Deutschland*, Leipzig u. Berlin, 1912, p. 83.

[10] H. Grünbaum, *Der mathematische Unterricht an den d. mittleren Fachschulen der Maschinenindustrie*, Leipzig u. Berlin, 1910, p. 71; G. Ehrig, *op. cit.* P. 22.

be brought into closer union with the simple equation. The advance guard of German teachers is emphasizing the concept of variation, of functional relation, with its graphic representation, by the use of squared paper. Can the graphic representation of *empirical* data not be taught earlier than customary? The experiment is worthy of careful trial. In a few schools it has been tried. Here is the testimony from the head of the manual training school of Christ's Hospital[11]: "Compare for example the mental attitude towards graphs of a boy whose first experience of the linear graph is derived from the set obtained in an experiment performed by himself with that of a boy whose first knowledge of a linear graph is obtained from a text-book of algebra. . . . The author who, in the desire to be 'practical,' introduces in his book graphs of results obtained in experiments which boys have *not* themselves performed or seen, runs the risk of being charged with attempting to force a false and artificial correlation between mathematics and another science."

The lack of inner connection between topics in German commercial arithmetics is deplored in a report prepared by Penndorf.[12] A unifying element for the various parts of arithmetic is the equation. The introduction of it in a simple, careful way, at first without the use of negative numbers, has been found not only to impart a coherence between different parts of arithmetic, but also to supply an easy symbolism, $y=ax$, for the expression of the functional idea. This mode of exposition is just beginning to find wider consideration in elementary German texts.[13] Other countries appear to have been in the lead in this particular respect. An Austrian report speaks of the emphasis early placed upon the solving of easy literal equations with respect to each of the letters contained therein.[14] An English teacher[15] suggests that algebra "should have its starting point at problems leading to simple equations, or at mensuration formulae such as: area of a triangle$=\frac{1}{2}bh$."

Of importance is the emphasis placed upon mental arithmetic, especially for commercial demands. In this respect foreign countries have been in the lead. The money-earning significance of mental arithmetic, even for girls, has come to the notice of American teachers through the criticisms passed by heads of our department stores and similar establishments. Many a high-mind-

[11] *The Teaching of Mathematics in the United Kingdom.* Report No. 12, London, 1912, p. 10.
[12] B. Penndorf, *Rechnen u. Mathematik im Unterricht der Kaufmännischen Lehranstalten*, Leipzig u. Berlin, 1912, p. 95.
[13] H. Grünbaum, *op. cit.*, p. 72; G. Ehrig, *op. cit.*, p. 44.
[14] *Bericht über den math. Unterricht in Oesterreich*, Heft 4, Wien., 1910, p. 48.
[15] *The Teaching of Mathematics in the United Kingdom.* Report No. 3, London, 1911, p. 9.

ed girl of attractive appearance has been found wanting because of her inability to do the arithmetical computations connected with ordinary sales and the making of change. The same problem arose in Berlin and was attacked in this wise. A committee composed of representative business men mapped out a course of study to be pursued for three years in a compulsory continuation school for sales girls. The course was officially approved by the continuation school authorities. It went into effect in April of the present year. The course includes arithmetic and bookkeeping for three years, stress being placed upon rapid calculation. It includes also German and correspondence, the science of living, labor conditions, household arts, etc.[16]

A closer union of plane and solid geometry has been maintained in the old country than in the United States.[17] In elementary technical schools the limited time available for instruction, and especially for the study of problems growing out of the work-shop practice, renders such a union especially desirable.

The use of logarithms and the slide-rule can be introduced much earlier than is done at present. Simple considerations like $10^2 \times 10^3 = 10^5$, and $10^5 \div 10^2 = 10^3$ are sufficient to convey an idea of the theory. Then abundant drill should be given in the actual use of logarithmic tables and the slide-rule. The most difficult part in the use of the tables is interpolation. From Sweden comes the recommendation that four place tables be so constructed that interpolation is done away with.[18] Experiments carried on in Sweden with parallel classes showed greater speed and accuracy resulting from the abandonment of interpolation.

The use of concrete multipliers has found little favor in elementary schools in Europe,[19] though the subject has been agitated a few times. In my judgment there is an opportunity for American trade schools to take the lead in this matter. There seems to be no greater objection to the introduction of expressions like 7 cm. x 8 cm. = 56 □ cm., or 7 kg. x 5 m. = 35 kgm. than there is to the introduction of negative numbers into algebra. We have, in fact, been in the habit of using concrete multipliers, without perhaps being aware of it, in saying that 1-half times 3-eights are

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[16] *Report of the Commissioner of Education for 1912,* Washington, 1913, Vol. I, p. 548.

[17] *Bericht über math. Unterricht in Oesterreich.* Heft 1, Wien, 1910, p. 37; Schotten's *Zeitschrift*, Vol 42, 1911, p. 570.

[18] *Der math. Unterricht in Schweden*, Stockholm, 1911 (Carl Heüman, p. 21).

[19] W. Lietzmann, *op. cit.*, p. 67; Hoffmann's *Zeitschrift*, Bd. 15, 16; O. Lodge, Easy *Mathematics,* London, 1906, Chap. V, XXVI, Appendix II; A. Lodge in *Association for the Impv. of Geom. Teaching.* 14th Report, Bedford, 1888, pp. 47-70, also 17th Report, 1897, pp. 10-22.

3-sixteenths. Practical convenience seems to demand this extension.

Of some interest, possibly, may be the attitude toward examinations maintained in elementary trade schools across the Atlantic. In a general way it may be said that the system of examinations is much more thoroughly entrenched in schools abroad than here, though in recent years old country rigidity has been lessened somewhat.[20] The experience in teaching of practical mathematics in England offers interesting information on this point. It is found that practical work cannot be readily tested by the ordinary type of examinations. "Results as tested by examinations may be disappointing," writes Mr. Bell.[21] "It is hard to devise an examination which is a fair test, but this does not condemn the work. The boy understands what he is doing, as shown by the fact that he can make use of previous experiments, and make correct deductions from them; but it needs a much higher standard of training before he can show an examiner that he understands." We read further, "If possible, we must suit our methods of examination to the methods of teaching, though it is admitted that there may be serious difficulties in doing this. The difficulties may be surmountable; but even if they are not, it would seem to be undesirable to alter sound methods of teaching to suit examinations. And meanwhile we must be prepared for anomalies wherever examinations come into contact with new methods." Whatever the actual *practice* may be, few teachers champion the *theory* that methods of teaching be altered to suit the examinations. Their sane judgment is that we should modify the examination so that it becomes a real test of the kind of efficiency aimed at. If the aim of the instruction is not primarily to develop power of expression, but to develop a certain manual dexterity, or to make a certain type of drawing, or to carry out some observation or experiment, or to perform computations of costs, then the examination should follow strictly the same lines. We do not test the quality of foot-ball coaching by requiring the team to take a written examination. In Germany this feature appears to be recognized. The examinations are conducted by practical men. "An apprentice does not become a journeyman . . . . merely by serving a specified number of years. For apprentices who have served their time, examinations are held in the continuation schools by the guilds or by the Chamber of Trades. Those who have a bad record at the continuation schools, or who fail in

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[20] *Bericht über den math. Unterricht in Oesterreich.* Heft 1, Wien, 1910, pp. 49-60; *Nature*, 1912, pp. 587-589.

[21] *The Teaching of Mathematics in the United Kingdom*, Report No. 33, London, 1912, p. 8, 9.

these examinations, may be kept an extra year at the continuation schools. Those who show sufficient knowledge and skill receive a journeyman's certificate."[22]

In German continuation schools, the technical instruction generally includes the elements of geometry, drawing, the handling of materials, tools, machines and working models. In some few large industrial continuation schools the rudiments of algebra, physics, chemistry, natural science and mechanics are taught. The problem how to make science teaching in industrial high schools contribute toward a greater immediate efficiency gives rise to interesting questions. In the teaching of chemistry in secondary schools England has emphasized the pedagogical side and the training in scientific method. In America the aim has been to offer a scientific treatment of the elements of the science.[23] For the purposes of those continuation schools and industrial high schools which teach chemistry or physics, neither type of instructional method is satisfactory. The latter schools demand differentiation and specialization. The selection of such topics as are of immediate value to the pupil or the trade, is the primary consideration. The keynote to the instruction in the Leather-sellers College at Bermondsey in London has been the chemistry of tanning, in the L. C. C. School of Photo-engraving it has been the "three-color" process.[24] The German attitude is indicated by the outline of the elementary course in a Munich trade school for tanners. Pupils conduct experiments touching the production of white leather, the glacé- and chamois-dressed leather; they study the chemistry of hard and soft water, of the detection of injurious material in water, and of other technical matters of importance in tanning.[25]

In the selection of topics and of their sequence, the question of logical order and of mental gymnastics is receiving less and less attention. Instead of beginning with definitions and general principles, the tendency now is to begin with such problems and apparatus as the pupil meets in daily life, as, for instance, a water motor, a hoisting frame or a gas stove. The formulation of principles involved comes last. This modern tendency may result in much good and also in great harm. There is danger of going too far. There seems no good reason why one should abandon the old practice of leading up gradually by a series of well-ordered preliminary exercises to the study of the more difficult topics.

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22 *Leith School Board, op. cit.*, p. 4.
23 "Industrial Education" in Monroe's *Cyclopedia of Education*, 1912.
24 *Nature*, Vol. 91, 1913, p. 281.
25 *Organization und Lehrpläne der obligatorischen Fachu. Fortbildungsschulen für. Knaben in München. Mit einer Einleitung von Schulrath Georg Kerschensteiner.* München, 1910, p. 132.

The sequence of topics is often a vital question. For example, should the study of electricity be begun with static electricity or current electricity? Static electricity still maintains its place of priority in some old country technikums of good standing. Mr. C. E. Ashford, formerly at Harrow, now of the Royal Naval College at Dartmouth,[26] makes a convincing plea in favor of current electricity because of the practical applications which appeal to the ordinary boy, and the mastery of which adds to the boy's immediate efficiency.

It might be argued that not only should we begin, as suggested, with current electricity, but we should start the course in electicity with a study of the dynamo. Thereby the young boy is confronted at once with the subtleties of this most highly developed practical electric machine. Such a procedure raises the question of driving young boys too rapidly, of over-estimating their capacity. Here, as elsewhere, it is highly necessary to observe moderation.

The charge has been made that American eagerness to reach immediate and startling reforms has led to great mental epidemics, which have periodically swept the American people. Great excesses are committed, followed by reactions to opposite extremes. I greatly fear that American education has not always been free of this charge. But it is now generally recognized that we cannot afford to expose ourselves to such reckless procedure. The suggestions from abroad are for good or for evil, according to the degree of mental equipoise with which we receive them. The departure from logical order of development, to secure the immediate consideration of practical topics, calls for the exercise of no little restraint. The stress laid upon the applications of science may degenerate into the study of rules, devoid of attention to underlying principles. The avoidance of abstractions may lead to the avoidance of all thought. The unification of mathematics is a bane or a blessing, according to our degree of precipitous haste, or of progressive conservatism.

In this brief address I have endeavored to present to you some of the thoughts and experiences of educators in the old world. I have looked back rather than forward. I have somewhat illuminated the track behind. You, as sober, practical men, who are advancing the great chariot of educational progress, will be able in your wisdom to reflect this light and use it as a searchlight for the exploration of the way ahead.

[26] *Nature*, Vol. 88, 1912, p. 393.

DEMONSTRATING SEASONS WITHOUT GLOBES.

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From time immemorial the stock mode of demonstrating seasons has been to show the pupils a globe on which, by some device, the limit of sunshine and place of vertical rays at different seasons are shown.

The fundamental defect in this way of presenting the subject is that it gives the pupil a view-point he will never occupy in experience. It takes him off the earth and shows him a sunlit earth as *seen from space*. The pupil is neither on the earth nor on the sun, but at some convenient point in space from which he can see both earth and sun in their relation to each other.

It is doubtful if most pupils who study seasons from globes ever get back on the earth in a way to picture the sun's yearly movement as it appears to an observer upon the earth. By noting the relation of the sunshine edge to the latitude circles at different seasons, the pupil gets a general idea how the length of day varies with latitude and the seasons. He can also calculate from his space view of the earth the height of the noon sun above the horizon of different latitudes at different seasons. The teacher, or pupil, may further succeed in demonstrating—by watching the direction of a pin's shadow, or otherwise—the general directions of sunrise and sunset at different seasons. Pupils are thus put in possession of the elements necessary to form a correct picture of the sun's seasonal movement as seen by an observer at different latitudes; but the elements have been separately and laboriously acquired, and vary so much with the latitude considered, that most pupils fail to piece them together into a correct and clean-cut image. Ask any class who have been taught seasons, however thoroughly, from globes, whereabouts in the observer's sky the sun is during the weeks, or months, of continuous sunshine in the summer of polar latitudes, or how the sun moves with reference to the horizon to give perpetual equinox at the equator, or by what path below the horizon the sun at a given season passes from its setting to its rising point. If any considerable number of pupils can give correct answers to such questions, their teacher has earned the right to retire on full pay.

The writer has wrestled for years with the globe demonstration of seasons without any flattering success.

Recently it has occurred to him, almost with the suddenness of

a revelation, that it is entirely unnecessary, and a great mistake, to ever take pupils off the earth in demonstrating seasons, and that for this purpose earth-globes and tellurians are a snare and delusion.

The essential point in demonstrating seasons without globes is to have the pupils understand and image clearly the relation of the horizon plane and zenith of different latitudes to the celestial sphere.

On the principle of "Divide and conquer," this relation should be studied out first on a non-rotating earth, and then the effect of rotation considered.

Pupils readily grasp the idea of the celestial sphere, or sky, as a hollow sphere of measureless size, on which the stars keep fixed positions relative to each other—forming dippers and other shapes —and which we view from within. Pupils also find little difficulty in understanding the sky poles as points on the celestial sphere in line with the earth's axis, and the sky equator, as a line around the sky above the earth's equator and midway between the sky poles. The sky poles and equator remain fixed through the year, because the earth's momentum of rotation keeps the axis parallel with itself, except for the slow top-like swaying that appears in the precession of the equinoxes, and because the earth's orbit, notwithstanding its 93,000,000-mile radius, shrinks to a point in comparison with the measureless celestial sphere. The sky poles being fixed points on the sky, and the sky equator a fixed line, it follows that any given fixed star is either on the celestial equator, or north or south of it a certain number of degrees, and that its distance from the equator remains constant. The number of degrees a star is from the sky equator is called its declination. Declination is for the inside of the celestial sphere what latitude is for the outside of the earth. North declination is called plus and south declination minus. Thus a star on the celestial equator has a zero declination, and one 30° north of the equator has a plus declination of 30°. Lines around the sky parallel with the sky equator are called parallels of declination. They correspond to parallels of latitude on the earth. So much for the celestial sphere.

Before attempting to picture the relation of the horizon plane of different latitudes to the celestial sphere the pupil must become familiar with fundamental directions for an observer upon the earth. These are determined by the earth's gravity. *Down* is toward the center of the earth. *Up* is away from the center.

A *vertical* line runs up and down. The observer's *zenith* is the point in the sky directly above him. It follows from these definitions that vertical lines are the radii of the earth extended, and that no two spots on the earth have the same zenith. Consequently, as one moves around on the earth his zenith shifts gradually on the celestial sphere. The fact that a traveler's zenith shifts *gradually* and at the *same rate* on the sky in whatever direction he goes on the earth—on a "level" surface—is the best proof, and the only proof needed, that the earth is spherical—i e. curved equally in every direction.

The pupil should now have no difficulty in locating on the celestial sphere the zenith of an observer at any latitude, such as the equator, the north pole, Chicago. He will not have gone far in locating the zenith of different latitudes before he discovers the important fact that *the declination of an observer's zenith always equals his latitude*—in direction and number of degrees.

The relation of observer's vertical and zenith to the celestial sphere having been made clear, the pupil is ready to consider how latitude affects the relation of the observer's horizon plane to the sky. It is evident that the observer's horizon plane (horizontal level) is at right angles to his vertical, and that it cuts the sky in a great circle 90° from his zenith. This circle is the observer's true horizon, and is to be distinguished from his sky-line, the line where "earth and sky seem to meet." In a mountainous country, or in a city, the sky-line, or lower edge of the sky as bounded by hills or buildings, is an irregular line. On the ocean, or a treeless plain, the sky-line is an even line, but falls a little below the true horizon on account of the curvature of the earth. Since the vertical at any point on the earth is the radius extended, an observer's horizon plane is perpendicular to the radius, or tangent to the earth at the point where he stands.

For an observer on the earth's equator, the zenith is a point on the celestial equator, and the north and south poles of the sky, being 90° from the celestial equator, are on the observer's horizon, directly north and south of him. Viewed from the earth's equator the celestial equator, being parallel with and directly above the earth's equator, crosses the horizon due east and west, and passes directly beneath the observer—through his nadir. To picture clearly the celestial equator and sky poles as thus viewed from the earth's equator, let the pupil, imagining himself to be at the equator, trace on his sky—with pencil point or index finger—the east and west vertical circle, and point to the sky poles on his north and south horizon.

As an observer travels northward from the equator, his vertical and horizon plane tip northward as many degrees as he goes, increasing to that extent the plus declination of his zenith, and throwing the north pole of the sky to the same extent above his horizon and the south pole below it. When he has reached Chicago, his zenith will be 42° north of the celestial equator, and the north pole of the sky will be 42° above the horizon—because he has tipped his horizon plane toward it that much. When Peary stood at the north pole of the earth the north pole of the sky was directly above him, and the celestial equator encircled his horizon.

At every latitude except the poles, the celestial equator crosses the observer's horizon directly east and west. To prove this let the pupil imagine himself at any latitude except the poles. If he then points one pencil at the pole of the sky that is above the horizon—whatever its altitude—and another pencil at the east or west point of his horizon, the two pencils will make a right angle with each other. This proves that the east and west points of his horizon are 90° from the sky pole. They must therefore be points on the celestial equator, because this runs through all points on the sky that are 90° from the sky poles.

It is also true that at every latitude except the poles the horizon bisects the celestial equator, since both horizon and celestial equator are great circles, and any two great circles on a sphere bisect each other.

The relation of observer's horizon plane to the celestial sphere may now be summarized as follows:

1. For an observer at the equator the celestial equator is an east-and-west vertical circle, and the sky poles are on the north and south points of the horizon.

2. Viewed from either pole of the earth, the corresponding pole of the sky is overhead, and the celestial equator encircles the horizon.

3. For latitudes between the equator and the poles, the altitude of one sky pole above the horizon and the depression of the other below it equals the latitude—in number of degrees—and the celestial equator crosses the horizon due east and west, with the half above the horizon slanting from the vertical position as many degrees as the latitude, but in the opposite direction, leaning southward from the zenith for northern latitudes, and vice versa.

To aid the pupil in picturing the relation of the celestial equator to the horizon of different latitudes, the teacher may use a

pasteboard disc to represent the horizon plane of supposed observer at center. Diameters drawn across the disc at right angles to each other will represent the north-to-south and east-to-west directions. Place the disc within a ring, or hoop—say an embroidery hoop—of the same diameter as the disc, so that the hoop crosses the ends of the east-and-west diameter. The hoop represents the celestial equator crossing the east and west points of observer's horizon. By rotating the hoop about the east-to-west diameter of disc—as if it were pivoted to the east and west points—it can be placed in right relation to the disc to represent the celestial equator as viewed from any latitude. The half of the hoop above the disc is leaned southward from the vertical position for northern latitudes, and northward for southern latitudes, as many degrees as the observer is supposed to be from the equator.

Before applying the above facts in determining the sun's seasonal movement as viewed from different latitudes, it is to be noted that the rotation of the earth does not change the relation of the observer's zenith and horizon plane to the sky poles and equator, because this relation depends solely upon the observer's latitude, and this is not changed by the earth's rotation. Throughout the day, notwithstanding the earth's rotation, the celestial equator and sky poles keep a constant position with reference to the zenith and horizon of any given latitude.

What the rotation of the earth does is to swing the observer around so that his zenith describes a parallel of declination on the sky, and his horizon plane faces in succession different parts of the celestial sphere, but with a constant slant to the sky equator and poles. Because of the eastward rotation of the earth, therefore, every sky object—star, sun or moon—seems to make a daily westward circuit of the sky, keeping a constant distance from the celestial equator and poles. In other words, the whole celestial sphere seems to rotate westward, about the sky poles as pivot points, once every 24 hours, at a slant to the horizon plane depending upon the observer's latitude. Until Copernicus' time this apparent daily westward rotation of the sky was thought to be real.

The sun's daily movement with reference to an observer's horizon at any time of the year depends upon its position as a sky object, in other words, upon its declination, or distance and direction from the celestial equator.

To explain the sun's yearly movement with reference to the celestial equator, use a pencil for the earth's axis and thrust it through the center of a pasteboard disc of five or six inches diame-

ter, representing the plane of the earth's equator. Let the left hand represent the sun, and its forefinger pointing horizontally at the center of pencil and disc the sun's rays directed toward the center of the earth. With the right hand carry the pencil and disc part way around the left hand, keeping the pencil vertical and the disc level with the left hand. With the axis thus vertical—perpendicular to the direction of the sun—it is evident the sun would remain constantly in the plane of the earth's equator—i. e. would be continually on the celestial equator. If now the pencil is inclined 23½° from the vertical and moved around the left hand with a constant slant in the same direction, the plane of the disc, now tipped 23½° from its horizontal position, will cut the sun but twice in a revolution, at points in the orbit directly opposite each other, or six months apart. During the half of the year that the north pole inclines toward the sun the sun is seen to move gradually to a position 23½° north of the celestial equator (above the plane of the disc), and back again, and during the other half of the year to move an equal amount to the south of the celestial equator (below the plane of disc) and return.

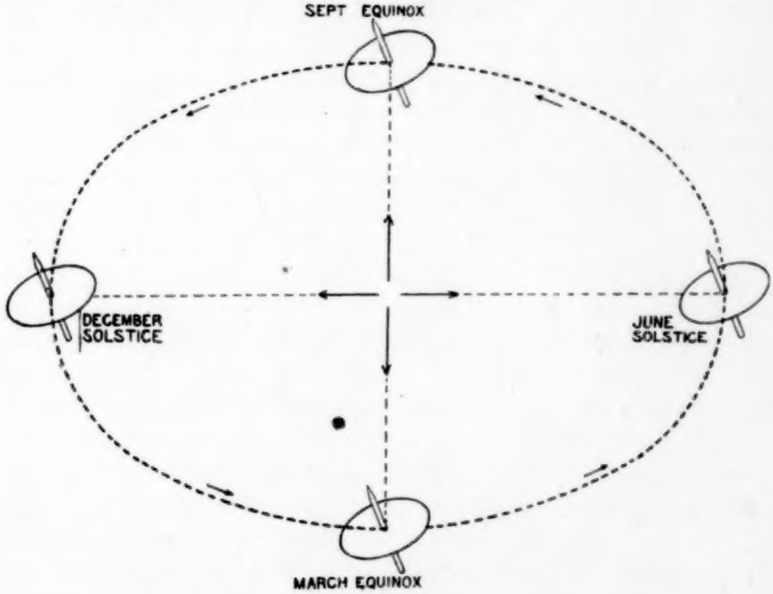

FIGURE 1.

As a sky object, then, the sun's declination is constantly changing, the sun being on the celestial equator at the equinox dates (March and September), and 23½° to the north or south of the

sky equator at the solstice dates (June and December), as shown in Figure 1, which illustrates the mode of demonstrating the sun's yearly movement on the sky just described, the arrows at the center taking the place of the index finger of the left hand, and the pencil and disc being shown in the equinox and solstice positions.

To study out now the sun's seasonal movement with reference to the horizon of any latitude, the pupil need keep in mind but two facts, namely:

1. That the constant inclination of the earth's axis makes the sun change its declination slowly during the year in the manner just demonstrated.

2. That the eastward rotation of the earth makes the sun appear to move westward around the sky in a complete circle every day.

Let the pupil begin his detailed study of seasons by imagining himself at the north pole on March 21st. Viewed from this point, the north pole of the sky is directly above him and the celestial equator coincides with his horizon—as noted before. The sun being on the celestial equator, the eastward, or counterclockwise rotation of the earth will make it appear to glide clockwise around the horizon. From March equinox to June solstice the sun, in going north of the celestial equator, will rise gradually above the horizon, while making a complete circuit each day. The sun would thus wind its way up from the horizon by a coiling or screw-thread movement, making approximately 90° daily circuits of the sky to rise 23½°—an average of ¼°, or ½ the sun's width each day. From June solstice to September equinox the sun would wind its way back to the horizon by the same screw-thread movement. It would thus be above the horizon continuously for six months. Between the September and March equinoxes the sun would coil its way to a position 23½° below the horizon and return, being most of the time in the twilight belt—extending 18° below the horizon.

The seasons produced by such a yearly movement of the sun are easily figured out—an extremely cold winter reaching its lowest temperature in February, and sufficient heat in June and July—through the continuity of the sunshine—to make polar dashes impossible on account of open stretches of water, or the jamming together or southward movement of ice-floes.

Let the pupil now transfer himself in thought to the earth's equator, arriving there March 21st. The poles of the sky are on the north and south points of his horizon, and the celestial equator

is an east-and-west vertical circle. Being on the sky equator, the sun will follow the sky equator path with reference to the horizon, rising due east, passing overhead at noon, setting due west, and passing directly beneath at midnight. Since the observer's horizon plane cuts the sky poles, it bisects the celestial equator, making the days and nights equal. Combining, as before, the northward movement of the sun, due to the slant of the earth's axis with its daily westward circling of the sky caused by the earth's rotation, the sun will coil its way northward from the east-and-west vertical circle, crossing the east and west horizons and passing the zenith and nadir points a little farther to the north each day, until at the June solstice it will rise and set $23\frac{1}{2}°$ to the north of east and west and pass the zenith and nadir the same number of degrees to the north. From June solstice to September equinox the sun will return to the east-and-west vertical circle by the same winding path. During the December half of the year the sun will coil its way to a position $23\frac{1}{2}°$ to the south of the east-and-west vertical circle and return. Viewed from the equator, the daily circling of the sky by the sun is always around a point on the horizon—the north or south pole of the sky, according as the sun is north or south of the celestial equator. The horizon plane, therefore, always bisects the daily path of the sun, making the day and night equal. Thus the equator has perpetual equinox.

The temperature seasons at the equator are due to the sun's seasonal movement just described. It is pretty hot all the time because the sun passes nearly overhead every day of the year, never crossing the meridian more than $23\frac{1}{2}°$ from the zenith. The yearly range of temperature is small because the days and nights are equal the year through, and because at a slant of $23\frac{1}{2}°$ from the vertical—the farthest the noon sun gets from the zenith—sunshine loses but 1/10 of its vertical strength, a given beam of light covering only 1/10 more surface at a slant of $23\frac{1}{2}°$ than it does when perpendicular—as can be shown merchanically or by computation.

Let the pupil next imagine himself at some latitude between the equator and the poles—say 60° north latitude—and proceed as before to trace the sun's course with reference to his horizon. His first step is to place the sky poles and celestial equator as seen from supposed latitude. At 60° north latitude the north pole of the sky is 60° above the horizon and the south sky pole 60° below it, the horizon plane being tipped northward that much from the equator position in which it cuts both sky poles. At this latitude the celestial equator would cross the observer's horizon due east

and west—as at all other latitudes, except the poles—and would slant 60° southward from the east-to-west vertical plane—i. e. the half above the horizon would slant southward. Viewed from 60° north latitude the equinox sun will therefore rise due east, pass 60° south of the zenith at noon, and set due west, and be above the horizon for 12 hours—the horizon always bisecting the celestial equator, as shown above. While winding its way northward from the celestial equator, from spring equinox to summer solstice, the sun, as viewed from 60° north latitude, circles around a point 60° above the horizon—the north pole of the sky—with a gradually shortening radius. It is evident that this will carry the noon sun higher and the rising and setting points of the sun northward from east and west, and bring the midnight sun nearer the northern horizon, and thus lengthen the day by lessening the daily dip of the sun below the horizon. As the sun coils its way back to the celestial equator, circling around the north pole of the sky with a lengthening radius, the rising and setting points of the sun approach the east and west again, the noon sun sinks back toward a zenith distance equal to latitude, and the daily dip of the sun below the horizon increases, lengthening the nights at the

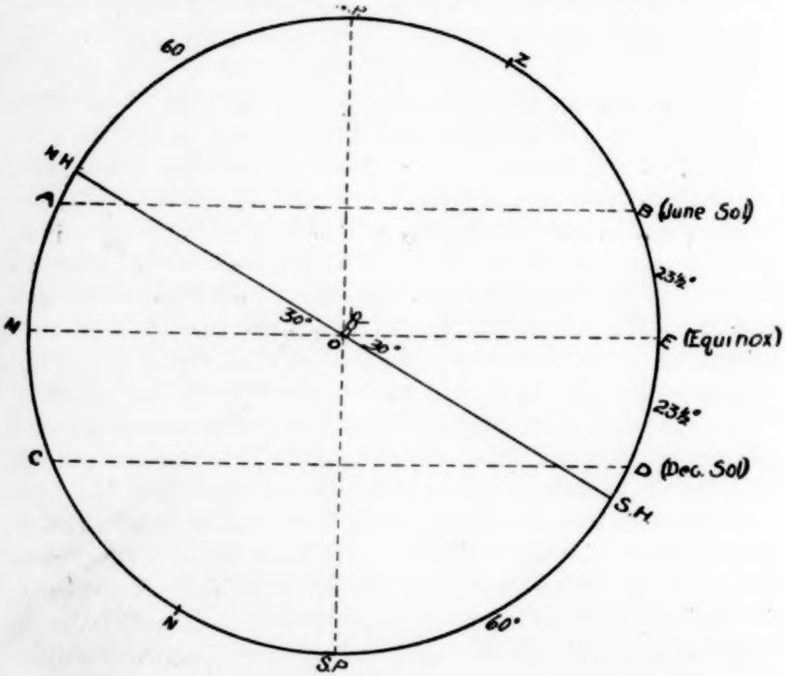

FIGURE 2.

expense of the days. From September equinox to December solstice, the sun winds around a point 60° below the southern horizon carrying the noon sun lower, and its rising and setting points southward from east and west, thus decreasing the diurnal arc of the sun and increasing its daily dip below the horizon. And then, as the radius with which the sun circles the south pole of the sky lengthens again from December to March, the noon sun mounts higher, the rising and setting sun approaches the east and west and the days and nights even up in length.

A diagram like Figure 2, made by the pupil under guidance of the teacher, will aid in picturing the sun's yearly movement as seen from any given latitude. Figure 2 shows the sky poles and equator in right relation to the horizon plane for 60° north latitude, as just described. NH and SH represent the north and south points of observer's horizon. Z and N are zenith and nadir. NP and SP are the north and south poles of the sky. E and M are the highest and lowest points of the celestial equator—where the equinox sun is at noon and midnight. B and A show the position of the noon and midnight sun at the June solstice, and D and C the location of the noon and midnight sun at the December solstice. The observer, O, at center of the meridian circle, is pointing at the celestial equator with one arm and at the north pole of the sky with the other.

All the essential facts relating to the sun's movement as seen from supposed latitude appear in the diagram. At equinox the noon sun is 30° above the southern horizon and the midnight sun 30° below the northern horizon, and the days and nights are equal. At June solstice the noon sun is $53\frac{1}{2}°$ $(30° + 23\frac{1}{2}°)$ above the southern horizon and the midnight sun $6\frac{1}{2}°$ $(30° — 23\frac{1}{2}°)$ below the northern horizon, and in passing from noon to midnight positions and back, the sun crosses the horizon far to the north, making the days much longer than the nights. At December solstice the noon sun is but $6\frac{1}{2}°(30°—23\frac{1}{2}°)$ above the southern horizon and the midnight sun $53\frac{1}{2}°(30° + 23\frac{1}{2}°)$ below the northern horizon, and the days are very short with the sun crossing the horizon as far to the south as it did to the north at June solstice.

It is evident from the diagram that at the supposed latitude the winters would be very cold, on account of the short and low diurnal arc of the sun, and the summers rather warm, because of the long days and the height of the noon sun.

By constructing and interpreting a similar diagram for 60° south latitude, as shown in Figure 3, the pupil will readily understand why northern seasons are reversed south of the equator.

With the south pole of the sky above the horizon, the long days and high noon sun occur around the December solstice, and the short days and low diurnal arc of the sun around the June solstice.

The method of demonstrating seasons here described and illustrated is believed by the writer to be superior, by every pedagogical principle, to the globe demonstration now so generally employed.

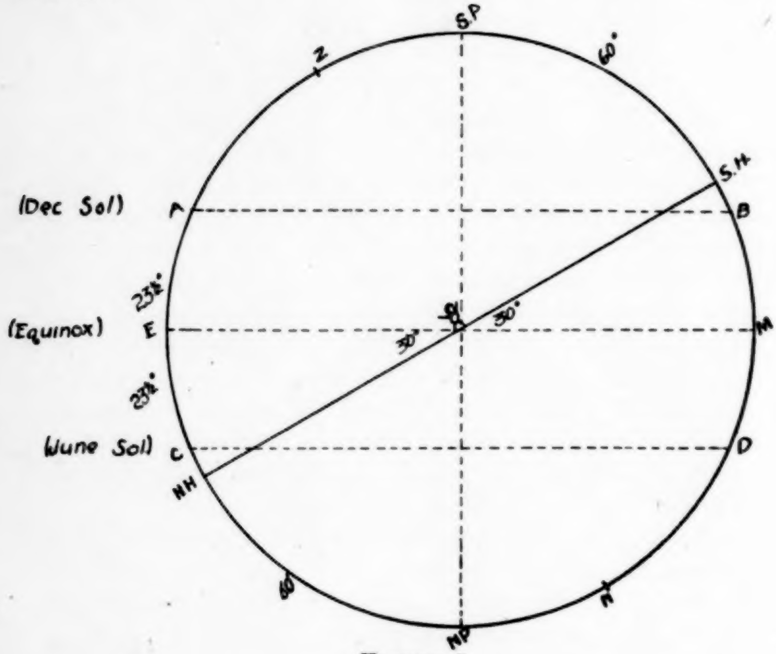

FIGURE 3.

The globe method of teaching seasons takes the pupil off the earth at the start. Like some huge giant suspended in space, the pupil takes the earth, in the form of a 6-inch globe, in his hands, and holds it in various relations to the sun, or some artificial light, to see where the sunshine edge passes and where the noon sun is vertical at different seasons. To determine the length of summer and winter days at different latitudes, he counts the meridian spaces conveniently laid off for him on his tiny earth.

To be of any service in interpreting or anticipating experience, the space knowledge of seasons thus acquired must be converted into terms of possible experience. In other words, the pupil must contract to his proper dimensions and get back on the real earth. This is where the rub comes in this method of teaching seasons. As stated at the beginning of this paper, the several elements that

enter into the picture of the sun's yearly movement as seen from different latitudes—namely, the height of the noon sun, the place of sunrise and sunset, and the length of day—are separately and laboriously acquired through inspection of globes, and vary so much with the latitude considered, that most pupils—and possibly some teachers—fail to piece them together into a correct and clean-cut image.

The method of demonstrating seasons here advocated keeps the pupil on the earth throughout. It is simpler and more direct than the globe method, and connects immediately with the observation and possible experience of the pupil. Questions that bewilder the globe student of seasons are easily answered by pupils who have been taught seasons by the globeless method, as the writer knows from experience with three classes, two in astronomy and one in physiography. For example, to locate the noon and midnight sun for any latitude at any season, the pupil who has been kept on the earth while studying seasons has to ask himself but two questions: 1. What is the altitude of the sky pole at the given latitude? 2. What is the distance of the sun in degrees from that pole at the season in question? Thus at 70° north latitude the altitude of the north sky pole is 70°. On June 21st the sun is 66½° from the north pole of the sky (23½° north of the celestial equator). Imagining the sun to circle around the north pole of sky with a 66½° radius, it is evident it would reach 46½° beyond (south) of the zenith at noon, and would miss the northern horizon by 3½°.

Besides giving a usable knowledge of seasons the globeless method of teaching the subject has the additional advantage that it gives pupils a good introduction to astronomy by acquainting them with the diurnal motion of the stars, as viewed from any latitude, and putting them in the way of understanding the equatorial mounting of telescopes and the method of determining the form and size of the earth.

The writer is so fully convinced of the pedagogical superiority of the globeless method of demonstrating seasons that he feels certain it will displace the present globe method wherever it is given a fair trial. To make the trial of the new method a fair one it must be strictly globeless. To mix the globe and globeless methods of season demonstration is to make "confusion worse confounded."

The writer will welcome questions, criticisms and suggestions from any and all teachers interested in the proposed revolution in the teaching of seasons.

A GRAPHICAL STUDY OF VIBRATORY MOTION.

BY S. R. WILLIAMS,
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Some students grasp more readily the significance of a problem by reasoning from analogy. For such students I have found the following graphical analogy between simple harmonic motion and damped vibratory motion particularly helpful. There is nothing new in the idea[1] but it would seem to the writer that damped periodic motion might receive more attention and be as readily understood by college students as simple harmonic motion. It is the purpose of this note to call attention to some rather striking relations between these two forms of oscillatory motion. Our college text-books devote not a little space to S. H. M. which is good so far as it goes, because of the wide application the theory of S. H. M. finds in every branch of physics. But after all, S. H. M. is largely an ideal type of periodic motion. The swing of the pendulum, the vibration of the tuning fork, the displacement of the ether, as in the case of wireless telegraph waves, all of them, are not strictly S. H. M's., but are to be discussed as damped oscillatory motion, because each succeeding vibration has a smaller amplitude than the preceding one.

Simple Harmonic Motion may be defined as the projection upon a straight line of the motion of a particle in a circle when the (constant) radius vector joining the center and the particle describes equal angles in equal intervals of time. That is, if one were looking along the line $\overrightarrow{TC}$, Figure 1, at a particle, P,

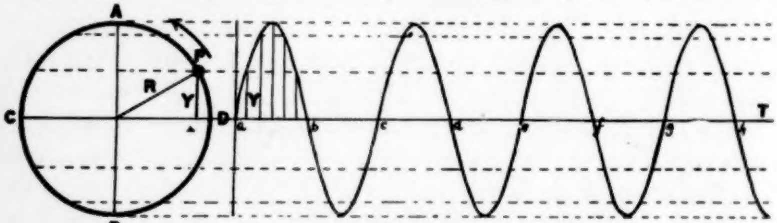

FIGURE 1.

moving around the circle, DACB, with a speed such that the radius vector, R, describes equal angles in equal increments of time, then P would appear to an observer at T to oscillate back and forth along the straight line $\overleftrightarrow{AB}$. The displacement, Y, at any time, *t*, from the line, CT, is given by the equation:

[1]Fleming: Principles of Electric Wave Telegraphy, pp. 2-4, 1906.

$$Y = R\sin\omega t. \qquad (1)$$

Where ω represents the angular velocity. This sort of motion may very easily be observed when viewing one of the balls of a steam engine governor in the plane of the circle which the balls of the governor describe when rotating with uniform motion. Numberless examples will suggest themselves. All one needs to look for is the uniform motion of some object in a circle and view that motion in the plane of the circle.

If along the line $\overrightarrow{CT}$, Figure 1, equal divisions are marked to represent equal increments of time, then the displacements of the point, P, at successive instants will be given by the curve, *abcdef,* etc., which we call a sine curve, the equation being of the form:

$$Y = R\sin\omega t. \qquad (1)$$

This sine curve is the trace one would get on a piece of smoked glass when drawn with uniform motion under a stylus attached to a tuning fork, if the vibrations were electrically maintained. The graph shows one striking characteristic of S. H. M.—that each succeeding vibration has the same amplitude. It would not, however, represent the vibrations of a tuning fork when simply struck once, for the oscillations thus set up soon die down or "tail out" as they say, of the vibratory discharge of a Leyden jar. An example is shown in Figure 2. This dying out or damp-

FIGURE 2.

ing of the vibrations is the common behavior of oscillatory motion and so far as possible we should try to get a clear idea of it in general physics.

In the case of damped vibrations the "circle of reference" seems to be one in which the radius is continuously decreasing and which shows it to be some type of an inverse spiral. If a curve similar to that shown in Figure 2 is plotted to scale it will be found that the displacements from the line, CT, will be given by the equation:

$$Y = ke^{-\alpha t}\sin\omega t. \qquad (2)$$

which is the equation of a curve representing damped oscillations.

In other words, our figure of reference for damped vibrations is an inverse logarithmic spiral, and has its analog in the circle as the figure of reference for S. H. M.

In Figure 3 a logarithmic spiral has been drawn and successive displacements of the vibrating point, P, have been plotted as in the case of S. H. M. in Figure 1. If one were looking along the line TC, Figure 3, at a particle moving counter clockwise around the spiral, DACB, with a speed such that the radius vector,

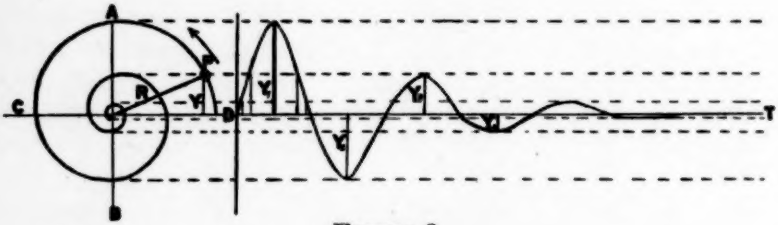

FIGURE 3.

R, describes equal angles in equal increments of time, then P would appear to the observer at T to oscillate along the straight line, AB, but each excursion would be smaller than the preceding one. The displacement, Y, at any time, t, is given by the equation:

$$Y = ke^{-at}\sin\omega t. \qquad (2)$$

Such a vibratory motion we call a damped oscillation. An illustration of this type of motion may be found in the conical pendulum. Suspend a ball by a *long* string and set the ball swinging in a *small* circle. Due to damping, the ball is gradually brought nearer and nearer its position of equilibrium, consequently the "circle" in which the ball is swinging grows smaller and smaller, or the ball describes what is actually a logarithmic spiral. The motion of a conical pendulum when viewed in the plane of the motion of the ball describes an oscillatory motion with decreasing amplitudes just as has been described above.

Damped periodic motion may be defined as the projection upon a straight line of the motion of a particle in an inverse logarithmic spiral when the (diminishing) radius vector joining the center with the particle describes equal angles in equal intervals of time. Since equal angles are described in equal increments of time, the instants of maximum displacements, t_1, t_2, t_3, t_4, etc., differ by a constant amount equal to T/2, the half period, or $t_2 - t_1 = t_3 - t_2 = t_4 - t_3 = T/2$, the half period or a constant. If we measure only Y_1, Y_2, Y_3, etc., the values of the

maximum displacements, then $\sin\omega t$ equals unity and the equations for successive maxima become:

$$\left.\begin{array}{l} Y_1 = e^{-at_1} \\ Y_2 = e^{-at_2} \\ Y_3 = e^{-at_3} \\ Y_4 = e^{-at_4} \\ \hline Y_n = e^{-at_n} \end{array}\right\} \quad (3)$$

which may be written:

$$\begin{array}{l} \log_e Y_1 = -at_1 \log_e e = -at_1 \\ \log_e Y_2 = -at_2 \log_e e = -at_2 \\ \log_e Y_3 = -at_3 \log_e e = -at_3 \\ \hline \log_e Y_n = -at_n \log_e e = -at_n \end{array}$$

therefore,

$$\begin{array}{lll} \log_e Y_2 - \log_e Y_1 & = a(t_2 - t_1) & = aT/2 = \text{a constant.} \\ \log_e Y_3 - \log_e Y_2 & = a(t_3 - t_2) & = aT/2 = \text{a constant.} \\ \hline \log_e Y_n - \log_e Y_{n-1} & = a(t_n - t_{n-1}) & = aT/2 = \text{a constant.} \end{array}$$

In other words, the difference between logarithms of successive amplitudes is a constant for any particular damped vibratory motion. For a pendulum swinging in air a would have a definite value, but for the same pendulum swinging in a medium of water a would take on another value. This constant difference of the logarithms of successive amplitudes is called the logarithmic decrement. Students of physics are familiar with the logarithmic decrement in the use of a ballistic galvanometer. Other analogies will present themselves to the reader.

OVER-CROWDED STREET-CARS.

A narrow car; seats filled with persons attempting to read newspapers while the car swings and jolts along its way; aisles jammed with men and women, boys and girls and tiny children, swaying and rubbing, one against the other, coughing and sneezing, pushing and pressing—what a sight for a progressive age; what a sermon for the moralist; what a despair for the student of public health and hygiene! Endless problems are presented by this picture, seen daily in nearly every American city, says *The Journal of the American Medical Association.* Most important is the menace to health from the thousands of bacteria, hidden in the throats of diseased men and women, and sprayed directly into a stagnant air, moist and unmoving in the absence of sufficient means of ventilation. Virulent organisms are inhaled into the throats and lungs of tired workers and tiny babes, who form an excellent host for their quick cultivation. The fare for the ride is small, but the cost cannot be estimated in terms of dollars and cents.

PHYSICAL PHENOMENA VERSUS ABSTRACTIONS.

By S. Leroy Brown, Ph. D.,
University of Texas, Austin.

Every teacher of elementary physics is prone to insist that their students learn to reason rather than memorize and yet the result is often little more than the memorizing of definitions and formulae with some skill in algebra. Students are allowed to deceive themselves by thinking that they have mastered a particular course in physics when their examination magazine is loaded with definitions and formulae. The teaching, however, often warrants the sort of preparation that the student has made and he finds that the examination is easy prey to his heavy charge. He can define momentum and work problems involving this physical entity without letting his mind wander to such realities as the destruction produced by a moving locomotive crushing into a box car or the velocity of a swinging block of wood after being struck by a bullet. If he is careful in the selection of symbols, he may be able to perform a beautiful piece of algebra which will give the range of a projectile[1] without any idea that he has done something that pertains to the throwing of baseballs and brickbats, or to the shooting of real projectiles from guns on board battle-ships.

Of course, the writer does not wish to infer that a keen memory and a good training in algebra are not valuable assets, in fact they are necessary for the successful teaching of physics and no one would think that definitions and formulae are not essential in the development of the science. The attempt to teach this science without the use of mathematics, definitions and formulae would be as ridiculous as a farmer trying to till the soil without farming implements. Care must be taken, however, in order that the teaching does not dwindle to a consideration of the adjuncts alone; a condition which could be compared to a farmer directing all of his attention to the perfection of farming machinery. The fundamental with the farmer is rich soil and the fundamental of the science is natural phenomena.

Teachers and students must realize that the object of their efforts is a study of real things and that all they do in the rational development of the science must be warranted by experimental facts. The physical laws are only generalizations

[1]The use of the word projectile in problems of physics has become so classical that few students think of anything so common as a cannon-ball when they hear or see the word.

which are founded on experimental facts but it is easily possible for students to lose sight of the fact that their study concerns physical realities. The logical development of the subject, like a course in mathematics, may be very interesting and has an educational value but the real object of the natural sciences is a better understanding of our surroundings. There must be something seriously wrong when students are "floundered" in an examination because they have forgotten a formula or the clause of a definition.

The remedy for the above mentioned evil, which might be called the segregation of the development of the science from the science proper, is a closer relation between the work done in the class room and the natural phenomena with which the student is familiar. This correlation can only be affected by refraining from speaking of definitions, formulae, laws, etc., without specific reference to their antecedents, natural phenomena. Velocity of a car and work done by a mule pulling a wagon are, perhaps, less elegant expressions but far more appealing to young minds than the velocity of a given mass and work done by a force.

There are three distinct ways of keeping abstractions from displacing concrete applications to things that are physical; three ways of keeping the development of the science from standing aloof the science: (a) Carefully designed laboratory work which will appeal to students as actually applying to the physical world around them. (b) Specific reference to experimental verification or measurement in every statement of principle, definition and formulae. (c) Problems involving specific reference to things with which the student is at least partially familiar.

Contrast the following laboratory exercises, definitions and problems and surely the superiority of the second statement in each case is evident.

1a. To prove experimentally that $R = \sqrt{a^2+b^2+2ab \cos \theta}$ to verify the law of parallelogram of forces.

1b. Experiment to show that the resultant of two forces exerted by cords pulling on a ring can be determined (in magnitude and direction) from the diagonal of a parallelogram when the two adjacent sides of the parallelogram represent (in magnitude and direction) the two forces.

2a. To verify the law of linear momentum.

2b. Experiment to show that when two ivory balls collide, the sum of the linear momenta of the balls before impact is equal to the sum of their momenta after impact.

3a. Work is the product of force and distance.

3b. The work done by a force (for example a horse pulling on a carriage) is equal to the force multiplied by the distance that the carriage moves in the direction of the force.

4a. The power of an agent is the amount of work that would be done by the agent if working uniformly for the unit of time.

4b. The rate at which an agent does work is called the power of the agent. Thus a locomotive exerts a steady pull of 15,000 pounds on a train and draws the train through a distance of 500 feet in 10 seconds. The work done is 7,500,000 foot-pounds which, divided by the time interval of ten seconds, gives 750,000 foot-pounds per second, as the rate at which the locomotive does work.

5a. The formulae for kinetic energy is $1/2m\,v^2$.

5b. The work done by a moving car while being brought to rest can be shown to be $1/2m\,v^2$ ergs if m is the mass of the car in grams and v is the velocity of the car in centimeters per second.

6a. What is the X-component of a force which makes an angle of 30 degrees with the X-axis?

6b. A mule pulls on a canal boat with a force of 600 pounds and the rope makes an angle of 30 degrees with the line of the boat's keel. Find the force which is effective in propelling the boat.

7a. What is the potential energy of a 1000 pound mass which is 20 feet above a zero plane?

7b. How many foot-pounds of energy would be delivered to a water-wheel by 1000 pounds of water falling 20 feet?

Much of the criticism that the physical sciences are impracticable and unwholesome can be obliterated if teachers will just add a little seasoning as indicated above. Of course, the sciences are not impracticable but the teaching is not always of the right kind to put them in the proper light. The reason that the sciences exist and why we may expect so much from their development is because they are essential to our everyday life. The material is all around us, we cannot get away from it no matter how hard we try, and we must convince students that principles, formulae, theories[2], etc. grow from these realities.

There is one dangerous result, however, which the demand

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[2]The average person uses the word theory as if it were not connected in any way with experimental facts. In fact, they use it as a blanket expression for all parts of the science which they consider have no practical value. Theory and nonsense are too often synonyms.

for practical things may bring about and that is a substitution of lighter but particularly practical subjects for the natural sciences. Trades schools have a valuable work to do but their training is not a substitute for a technical education. Shop work and domestic science are inestimable allies but not substitutes for botany, chemistry, physics and zoölogy.

A WORD OF WARNING IN CONNECTION WITH GENERAL SCIENCE.

BY HERBERT BROWNELL,
Teachers College, University of Nebraska.

To one familiar with the long continued efforts to promote Nature Study in the public schools and with its precarious existence through many years, together with the disheartening returns from school officials generally concerning the educational results from it as a branch of study, there is ground for apprehension lest the General Science movement only repeat these same experiences. Glowing accounts of wondrous success in nature work in scattered instances emphasize the wide differences between what might be true in elementary science in schools and what all too commonly is attained. Little need exists to dwell even for a moment upon the value in the high school of elementary introductory science work, nor upon the abundance of suitable and well-organized material for the teaching of General Science. Whether a place in the ninth grade of high school can be made for this work will depend upon teaching results where introduced. Arguments upon these points could be only for sake of argument, or because of unwillingness to grant anything in behalf of General Science as a separate branch of study.

On the other hand advocates of such a course need their combined wisdom and effort in at least two other respects if its place in the school curriculum and its full worth in the school work is to be assured.

Of these the most important is of course qualified teachers sufficiently well prepared in this particular branch to make it educationally indispensable in the school curriculum. Not specialists, but teachers competent in this branch even as in other high school work. They may or may not be the "science teacher," and their preparation may well be quite as much "pedagogical" as "scientific." But it is indispensable that they be able

to teach with marked success, teach that which is of exceeding great worth in the lives of the pupils generally, and presumably that which yields greatest aid in the subsequent high school sciences. This preparation may best have come in institutions of established reputation for the training of such teachers. It at least demands the background of a year's high school course in General Science under competent instruction.

In the second place, and it is here that it is desired especially to raise a voice of warning to advocates of General Science, the history of the Nature Study movement emphasizes the need that this later endeavor in the field of elementary science shall from the first be put upon the sure basis of a laboratory branch of study. Through rational laboratory exercises, both simple in requirements and qualitative in character, let the General Science be closely related to the high school sciences rather than made auxiliary to language lessons, to "art," or to "busy work." Then, too, let the course be continuous rather than fragmentary, beginning always in its several subdivisions with the common experiences of youth, and leading by closely related stages over into the realms of applied science and the affairs of life, and just so far as worth of subject-matter and fruitfulness in thought-exercise shall make it possible to go. An "entertainment course," with bits of this and that from the realm of science, is to be ruled out.

Any advance in knowledge and powers of mind in school days is so largely result of exercise in comprehending new relationships both in what has before been known when considered by itself, and then when taken in connection with added new matter, that there is irreparable loss in flitting from topic to topic of wholly unrelated matter simply to satisfy an unwholesome taste for the marvelous in science. Advocates of General Science cannot afford to make so grievous a blunder.

There are numerous books published that treat admirably the elementary phases of natural science, furnishing the facts and discussions well suited for the work under discussion. Very largely this material is rather widely scattered through the many books that have to do with the several high school sciences. It might be advantageous in many ways, and for the convenience of teachers, to bring this material together into narrower compass for the particular ends of the elementary science teaching. But after all, it is the spirit of General Science, as with the Nature Study, to learn in large measure direct from

nature's forms and phenomena. A book in the elementary science may be so used as to hinder rather than help, and made to come in between the pupil and that from which he is to learn. There is a wide difference between a study of nature's ways and works on the one hand, and reading about them on the other. The reading of guide books for travelers, and that only, makes a poor substitute for their use in connection with actual journeyings to the places described, and for personal experiences therewith. The study of the guide book might make one master of names and terms whereby to become able through glib recital of statements to delight ourselves and others. This at its best, however, is poor substitute for the mental stimulus possible in travel.

On the other hand, there are for the General Science all too few laboratory manuals that demand of the individual student a personal experience with the thought-provoking phenomena of the world about him. There is altogether too little use made of the fullness of his experiences as a key wherewith to unlock and open doors into an unknown that is all about him. Aside from valuable information thus acquired and organized as "knowledge worth knowing," such exercises of the laboratory stimulate a sense of power to achieve in the realms of intellect which make the pupil in some degree master of the forces of the natural world as these are seen operating in simple experiments controlled and comprehended by him.

These laboratory exercises may well constitute in some large measure a preparation for the instruction to be given in a succeeding class period. Then it is that there is afforded the best of opportunities for the teacher to give instruction in various related topics of large teaching values, and for which instruction the pupils are ready of comprehension. It may not be out of place to suggest here that such a manual instead of being prepared to accompany some text might very properly leave the teacher free to use material from any and all sources known by him or suggested to him. If there be a text, *let its use be to accompany the manual.*

Where a course in General Science is thus based upon laboratory exercises of an elementary character even the indifferently prepared teacher may be so effectively aided in the class instruction that the disheartening history of the Nature Study movement may be avoided.

PRACTICAL WORK IN THE HIGH SCHOOL.

By D. F. Dunster,
High School, Gridley, California.

Despite the tendency to make the high school a practical institution turning out young men and women fitted for some particular occupation, the actual performance of this important purpose is far from accomplished in the majority of instances.

The high school can never be substituted for the college in the matter of highly specialized work, but there are many lines of industrial pursuits in which well trained, semi-technical and thoroughly practical graduates of the preparatory school can take the place of college men without the necessity of spending four years in taking technical work, and the result will be much more satisfactory to the student and in numerous cases of benefit to the employer.

In this day of synthetic production of unnumbered products, the manifold substitution of the artificial for the real, adulteration of every conceivable food, drug and kindred products, it seems that it would be only fair to the student to so arrange the courses of the high school that a real working knowledge of subjects could be had in such a way as to equip a boy or girl to take some definite place in the ranks of business and industrial work.

It is true that in some cases in schools which are blazing a new path, that there are courses leading to a practical working knowledge of some few things, by allowing outside work to be done in conjunction with school work, but even in these schools there is often too much technical and theoretical work, the mastery of which is a serious detriment to the learning of the industry. While theory is of course necessary to college training, very little is necessary to the high school student, and, as a matter of fact, he does not take to it with any degree of interest in comparison with work which he may actually do and see the results of his labor. The same tendency to want to do things is manifest in the young student as in the desire of a child to handle objects, and by such contact become intimately acquainted with the object and its uses. As a result of these general tendencies, we should design courses and present them in such form as to require as little effort as possible to assimilate the knowledge.

In discussion of the advisability of introducing courses which prepare for industrial work, let us look for a moment into the places where we might reasonably expect a high school graduate

to "make good." In the laboratories of the great steel industry there are hundreds of so-called chemists whose sole duty is to perform one series of experiments relating to the composition of the various samples of steel as it comes from the mill, an occupation which does not require any great degree of technical knowledge, and which could be done by any young man who had studied simple qualitative analysis, and had been observant in association with his associate workmen. Proficiency is, in such cases, merely a matter of natural adaptation and real effort, supplemented with a good, not necessarily technical, training in the use of apparatus and handling of chemicals.

One of the large electrical companies of the country has a habit of employing college graduates to work in the various parts of its plants and expecting them to learn the business. There are many divisions of the work which require skill of a technical nature, but on the contrary, the greater part of the work done is mechanical and could be handled by high school graduates. One department in particular, that of the physical laboratory, has men who receive an average of about fifty-two dollars per month for doing purely mechanical work in making tests of the stress of wire, tensile strength, ductility, etc. These men are college graduates. There is nothing in this branch of that particular industry which could not be done by a young man who has had a good course of training in real experimental physics in the high school, and the salary offered is much more in accordance with the proper standard of beginners who are high school graduates than that of college specialists in the work.

Recently a graduate of the science course of an eastern college applied for a position in one of the laboratories of the sugar industry. He was asked, "Do you know anything about the particular work we have to do in this laboratory?" "No, I do not think I have been given the work which would make me familiar with your tests, but I am perfectly at home in a laboratory." The head chemist replied, "Well, it is not necessary for you to be able to do our work before you start, familiarity with chemicals and apparatus is all you need, and you will soon be able to handle tests."

This is another instance where there was practically no need of a college training, observation and ability to apply being held above the technical skill. The salary offered was sixty dollars per month.

No effort is made, in this article, to depreciate the value of a

college trained man, or to show that the high school graduate is able to compete with a college graduate. The former is not to be thought of, and common sense tells us that the college trained man has the advantage. There is, however, the great number of young men who do not attend college and who must get training which they will be able to substitute for the higher learning.

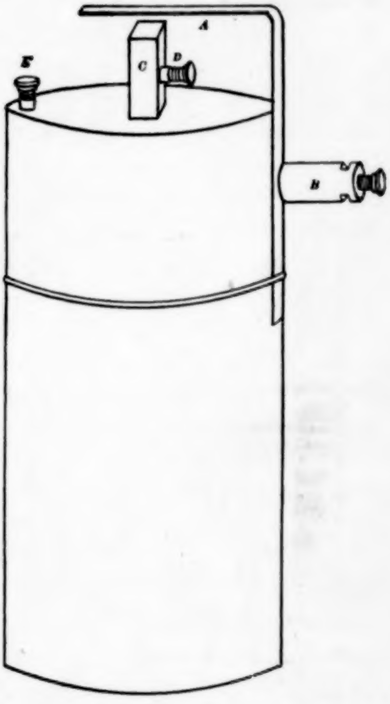
Much criticism is being directed toward the ever increasing number of the courses given in the schools, on the grounds that it leads to a scattered knowledge of many unimportant subjects. There is no doubt that it is very true, but the blame cannot all be laid at the door of the preparatory school. We are trying to satisfy the requirements of too many colleges and the few students who must, if they enter college, comply with those requirements. The result is a curriculum in which a student without a definite aim is hopelessly lost in trying to get anywhere. Much is to be said against "special courses," and as such, they are in many instances "snaps" for those students who do not want to stick at anything which demands effort. There are however those courses which are special in that they do not occur in the regular requirements for the entrance to college, but which may be in a course designed to lead to a definite preparation to do some particular kind of work.

As a system, the high school is at fault in catering to a small proportion of students who desire to enter college. The student who does not intend studying farther should have as much opportunity to follow his chosen profession and to prepare for it as the other. Both can be done as well as singling out any one class of students and giving the benefit all to that one. In the past the preparatory school has been simply a tributary to the college, but now it has become an institution by itself, and should be so conducted that it maintains its own standard and performs the functions of an institution which is for the benefit of its whole body of supporters, supplying those dependant upon it with that kind of knowledge which tends to make it a benefit, not only to the pupil but also to the community at large and to those branches of industry in which its graduates may take places of responsibility in all departments.

AN ELECTRICAL CONVENIENCE.

By H. C. Trimble,
Bradley Polytechnic Institute, Peoria, Illinois.

As a source of electric power for a number of electrical experiments in elementary physics the dry cell is a very convenient battery. One of the greatest difficulties met with in their use is to prevent them from being allowed to run longer than is necessary. Very often the first student who uses a cell permits it to remain attached to apparatus for a long time—perhaps long enough for all energy to be consumed. No amount of caution or watchfulness entirely avoids the trouble.



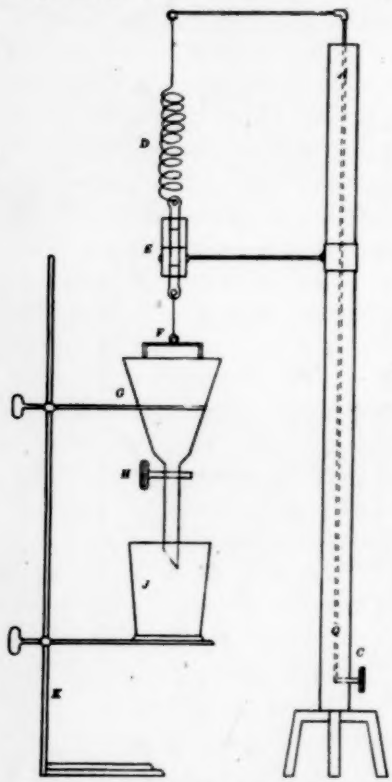
In order to diminish the loss occasioned by student carelessness, Mr. A. W. Jamison of the Bradley Physics Department has designed a key switch to be attached directly to the dry battery. It consists of a half-inch strip of spring brass bent at right angles into two arms 3 and 2 inches long. To the middle of the long arm a binding post B (see figure) is soldered. Then the long arm is rigidly fastened to the cardboard covering of the battery sides by wrapping with the wire W. The short arm A is so adjusted that a small pressure will cause it to touch the carbon C. Now when the student attaches the two ends of any electrical circuit to posts B and E, no current flows until he pushes down on A and stops as soon as the pressure is released. The cardboard between the brass strip and the zinc of the battery prevents a short circuit. Removing the nut from post D makes it entirely necessary for the student to use the key. The key renders it impossible for the current to be used without pressure applied by the student. As soon as the student starts some other work the key automatically stops the flow of current.

This device does not greatly complicate the work. It has been very successful in lengthening the life of our dry batteries and has more than repaid the work of making and fitting them.

A METHOD FOR DETERMINING THE SURFACE TENSION OF LIQUIDS.

By George W. Tidd,
Kansas State Normal School, Emporia, Kansas.

The writer does not claim originality for this method but does not recall ever having seen it described in print or ever having heard of its use. He has used it with good success in classes during the past year and does not know of a more reliable simple method for the determination of surface tension.



The arrangement of apparatus may be easily understood from an examination of the accompanying figure. The liquid to be tested is put into a glass funnel G that is provided with a valve H. The platinum form F is suspended in the usual way from the indicator rod E of a Jolly balance. C is the knurled head of the screw that is used to operate the rack device for raising or lowering the spring of the Jolly balance AQ. The liquid to be tested is poured into G until the required depth for F to be lowered by means of C until the arms of F are immersed and the mark on the indicator E is on the scratch. The zero reading then is taken and recorded. Then G is raised until a film is caught on F. The observer then cautiously opens H, allowing the liquid to slowly drop into J, while he keeps the mark and scratch in coincidence at E by adjustment of the screw C. By practice one can quickly learn the operation so that very concordant results may be obtained. The writer's classes obtained results with variations of about 5 per cent by use of this method, whereas it was difficult to keep the results within 20 per cent variation when the experiment was performed in the usual Jolly balance way by raising and lowering a dish of the liquid.

A STANDARDIZATION OF FLORAL DIAGRAMS FOR EDUCATIONAL USE.

By Helen A. Choate,
Smith College, Northampton, Mass.

All teachers of botany are familiar with floral diagrams as used in systematic treatises, and most of us have proved their value along educational lines. Considerable diversity exists, however, as to their use and method of construction, and after several years' experience in actual class work I have attempted to organize the subject in the hope of increasing their educational value.

In 1819 Turpin[1] devised the first floral diagram to explain the structure of the flower in grasses, the horizontal form alone being used. (Figure 1.) Later this method was largely employed by De Candolle, and since then such diagrams have been freely used, e. g. in the systematic works of Le Maout and De Caisne[2] and of Eichler,[3] in the wall charts of Henslow[4] and of Peter[5], and in text-books, both foreign and American.

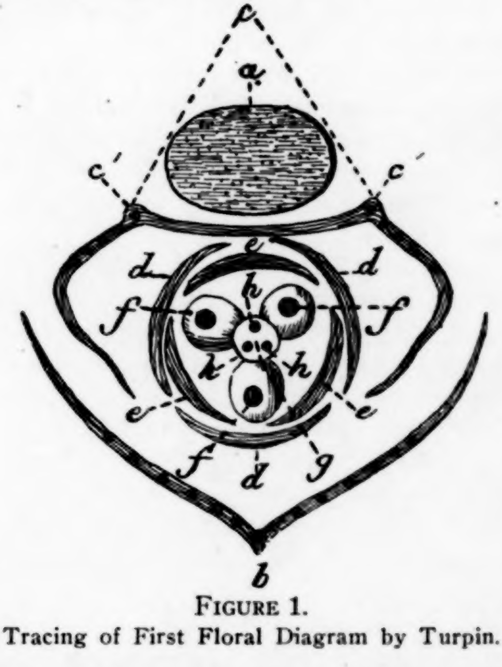


Figure 1.
Tracing of First Floral Diagram by Turpin.

1 Turpin, P. J. F. Mém. du Muséum, 5, 1819, pl. 30. 31.
2 Le Maout, E. and Decaisne, J. Trans. by Mrs. Hooker, A General System of Botany, London, 1876.
3 Eichler, A. W. Blüthendiagramme, Leipzig, 1875.
4 Henslow, J. S. Botanical Diagrams, London, 1857.
5 Peter, A. Botanische Fandtafeln, Wischer, Berlin.

In conjunction with these horizontal diagrams, so-called vertical or longitudinal diagrams of the flowers have been commonly used. Such diagrams in reality represent a view of one-half of the flower, obtained by cutting it longitudinally through the center. The true vertical diagram, however, differs radically from these half views in that it represents precisely the same kind of longitudinal section through the flower as the horizontal diagram represents across it. The first of such vertical diagrams that I have been able to find is in Schleiden's[6] *Principles of Scientific Botany*. These diagrams, however, were not so universally adopted as the others. Their introduction into this country appears to have been due to Professor Goodale of Harvard University, who has long used them in his teaching, and they have been adopted quite generally by botanists directly or indirectly indebted to him.

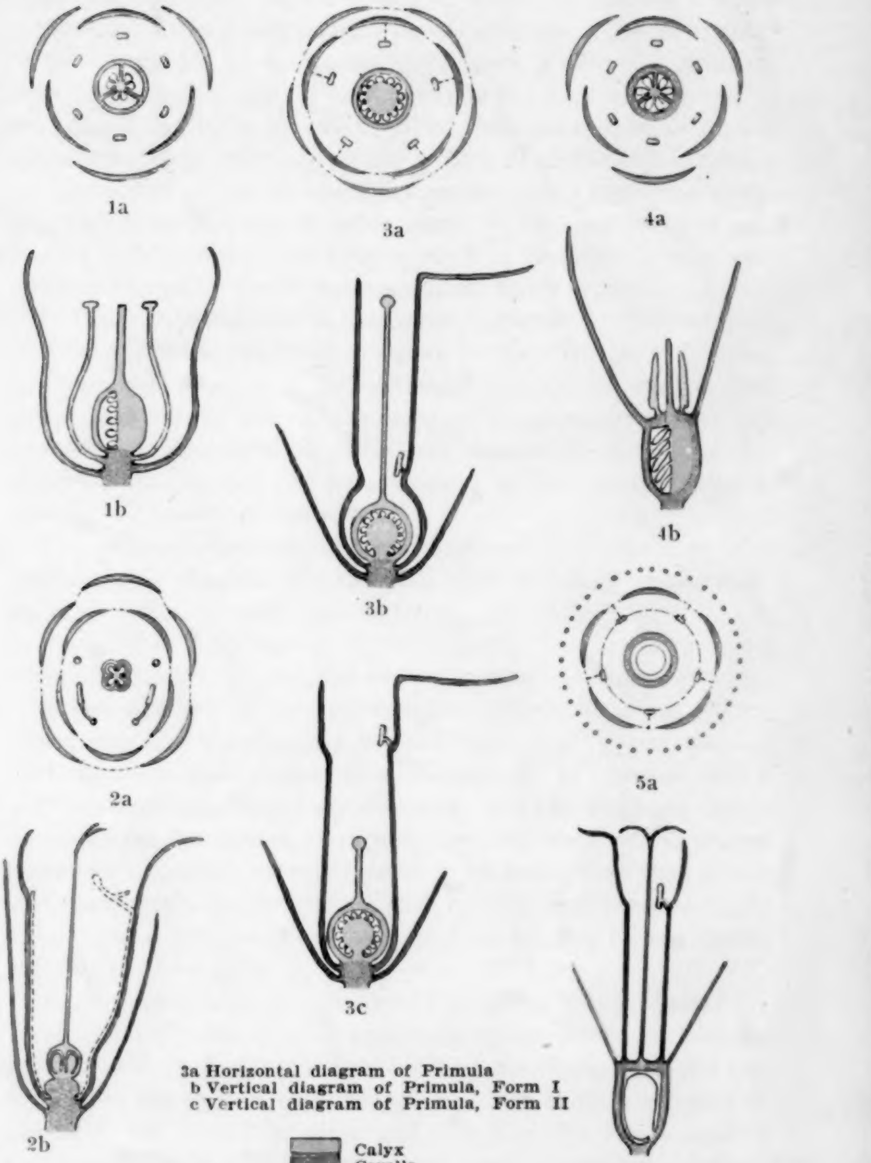
These complementary diagrams express very adequately the structure of any single flower, the horizontal showing the number and distribution of parts, the vertical the relation of parts to each other, while by a consistent system of coloring, or equivalent shading, the comparative morphology of any number of floral types may be shown by a series of diagrams.

The most satisfactory discussion yet published of these floral diagrams from the educational point of view is by Stevens[7], but after careful consideration and practical experimentation I am convinced that in many points his methods can be improved upon, and the accompanying plates embody the recommendations I would make.

The system of coloring here used, while differing from that suggested by Stevens, agrees very closely with those used by Henslow, Peter and McAlpine[8], although developed independently. The use of green for calyx and yellow for stamens is a natural choice based upon the characteristic colors of these parts. Of the remaining colors red seemed the most natural for petals, while the blue, brown and purple were so distributed that no confusion might arise from the close proximity of similar colors. The brown is used in place of the orange which Stevens proposes, as it is more commonly found in the collections of crayons provided for student use.

It will be noticed that blue is used for all tissue developed from the carpels, since a separate color for the stigma as suggested by

[6] Schleiden, M. J. Principles of Scientific Botany, 2nd Ed. Trans. by Edwin Lankester, London, 1849, pp. 320-321.
[7] Stevens, W. C. Introduction to Botany, Boston, D. C. Heath and Co., 1902, pp. 150-156.
[8] McAlpine, D. M. The Botanical Atlas, New York, The Century Co., 1883.



3a Horizontal diagram of Primula
b Vertical diagram of Primula, Form I
c Vertical diagram of Primula, Form II

Calyx
Corolla
Stamens
Carpels
Receptacle
Floral tube

1a Horizontal diagram of Scilla
b Vertical diagram of Scilla
2a Horizontal diagram of Salvia
b Vertical diagram of Salvia

4a Horizontal diagram of Galanthus
b Vertical diagram of Galanthus
5a Horizontal diagram of Cineraria (disc)
b Vertical diagram of Cineraria (disc)

Stevens seems unnecessary, while his proposal of an additional color for ovules on a basis of physiological use raises a needless complication in a purely morphological diagram. The floral tube[9] is here regarded as a separate floral part, a ring-like structure carrying up calyx, corolla or stamens as the case may be, and in no sense as a fusion of any or all of these parts, and as such is given a separate color. In all cases the wall of the inferior ovary is regarded as receptacle which has grown up in a cup form, carrying with it carpels and all other parts. Additional features pertaining only to individual flowers, such as nectaries, glands, etc., are best shown by simple outline without special color.

If it is not practicable to use colors, a system confined to black and white may be employed as shown in Plate II. Such a system is common in most texts, and while not as good for student purposes as the use of colors, it is more advantageous where the diagrams are to be published. The most satisfactory scheme of differential shading, the one here adopted, is that recommended in Ganong's *Teaching Botanist*.[10]

The primary requisite of these diagrams is to represent with unmistakable clearness the morphological structure of the flower, and to this all other considerations are subordinate. In size they should be large enough to show plainly the smallest feature, without, however, making the whole diagram unnecessarily large.

In the originals of the accompanying diagrams, which are reduced one-half, the diameter of both vertical and horizontal sections at their widest point is approximately two inches, which proves a most satisfactory working size. The two diagrams should be consistent throughout as regards size and shape of the several members. Another essential point is to make sure that in the vertical diagram no parts touch each other except where actually joined, and where one part grows out from another no line should separate the two parts.

In all diagrams great care should be given to mechanical accuracy, and the use of compasses and rulers should be insisted upon, provided always that the object of the diagrams is not lost sight of in the process of making them. All outlines whether in pencil or ink should be clear and firm and the colors applied softly and evenly. This latter point needs particular emphasis as students show a strong tendency to overcolor. The colors

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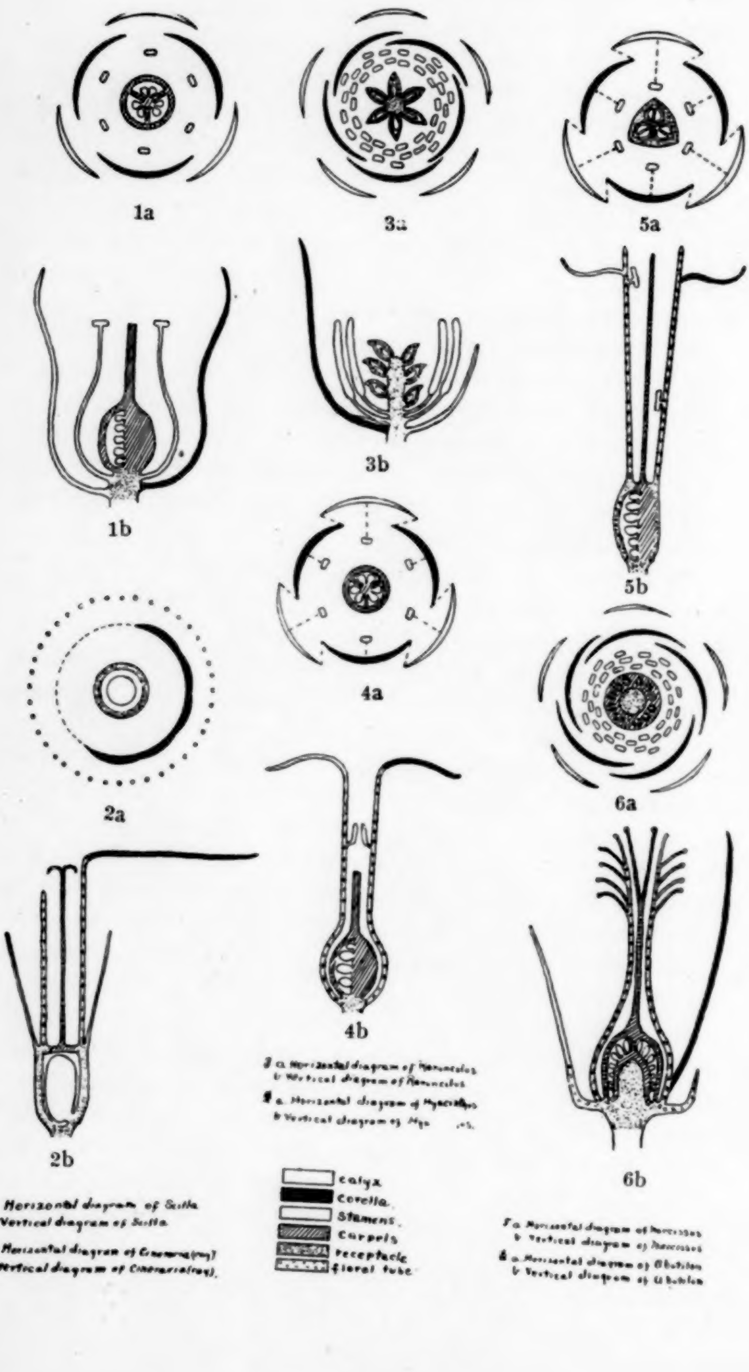
[9] As the floral tube is clearly shown in the vertical diagram, its presence is merely indicated in the horizontal one by dotting together those parts carried up on it.

[10] Ganong, W. F. The Teaching Botanist, 2nd Ed. The Macmillan Co., New York, 1910, pp. 353-355.


1a
3a
5a
1b
3b
5b
4a
2a
6a
2b
4b
6b
3 a Horizontal diagram of Ranunculus
b Vertical diagram of Ranunculus
4 a Horizontal diagram of Hyacinthus
calyx
Corolla.
Stamens.
Carpels
receptacle
floral tube
1a Horizontal diagram of Scilla
b Vertical diagram of Scilla
2a Horizontal diagram of Cineraria (ray)
b Vertical diagram of Cineraria (ray).
5 a Horizontal diagram of Narcissus
b Vertical diagram of Narcissus
6 a Horizontal diagram of Abutilon
b Vertical diagram of Abutilon

should be applied as lightly as consistent with distinct differentiation of the parts.

In simple flowers such as Scilla, Hyacinth, etc., these two diagrams are sufficient to bring out all important morphological features, but in others difficulty arises as to the best way of representing more complicated structures. In heterostyled flowers, such as Primula, the horizontal diagrams of the two forms are identical, but a vertical diagram of each form is needed. In the case of Fuchsia a single horizontal section clearly indicates the number of parts, but owing to its tetramerous arrangement no single vertical diagram can be made which will show satisfactorily sepals, petals, septa and loculi of ovary. In my opinon the most satisfactory solution of such a question is to make two complete vertical diagrams, the one showing sepals and septa, the other petals and loculi; a second method would consist in representing one-half of each of such diagrams on either side of a median line; a third method, used in the *Teaching Botanist,* seems to me decidedly inferior to either of the preceding methods, for, while the sepals, through not actually present in the section, may be indicated, the two views of the ovary cannot be satisfactorily combined. For such Compositæ as possess both ray and disc flowers horizontal and vertical diagrams of both will be needed. In the case of a Labiate (like Salvia) no vertical section showing floral tubes, calyx and corolla shows the stamens. To obviate this difficulty the best method seems to be to dot in such parts as are necessary for a clear understanding of the structures when such parts lie in a different plane from the rest of the section.

The question will inevitably arise as to the position in which vertical diagrams shall be placed on the page. Two methods are possible. The diagrams may all be placed in a perpendicular position without regard to the position of the flower in Nature, which may be horizontal or irregular. This method has been adopted here as it seems the one best suited to the majority of flowers and the one by which their comparative morphology may be most readily expressed. A second method would consist in placing all vertical diagrams in the natural position of the flowers, on the principle that whatever features can make these diagrams resemble more closely the actual flowers without interfering with their primary object is advantageous. Stevens' suggestion that the latter method be used because of the close connection between the position of the flower and its cross pollination introduces an ecological factor which is as much out of place in a morphological diagram as is the physiological one earlier mentioned.

To what degree of detail these diagrams shall be carried is a point which each teacher must decide individually, depending upon the age and degree of proficiency of the students. Two guiding principles may well be followed, (1) to show only as much detail of structure as can be shown without interfering with the clearness of the morphology; (2) to limit the features shown to such points as the student can determine with the naked eye or at the most with a hand lens. Such questions as the kind of ovule or anther, or the phyllotaxial arrangement of stamens in Ranunculus are probably too time-consuming in proportion to the value of the additional information gained to be worth while, if not actually beyond the range of the student's ability. The question also of the position of the flower in relation to the subtending bract and therefore to the stem, which is usually indicated in horizontal diagrams in works treating fully the structural characteristics of genera or families, is one demanding the careful study of far more material than the average student can command.

Above all it should be borne in mind that these diagrams are not an end in themselves but are merely a means of ensuring on the part of the elementary pupil a clear understanding of simple floral structure. Often if carried out in an absolutely logical manner they lose most of their value, and while it is conceivable that such diagrams might be constructed of some highly complicated flower showing the structural features in greatest detail, they would be of little use, for anyone who could deal intelligently with such problems would have long passed the stage where the construction of floral diagrams would have any educational value.

THE PRICE OF RADIUM PREPARATIONS.

Industrial journals report a marked reduction in the prices of radium preparations of late. The total production of radium bromide per year is between 2 and 3 gm. In 1911 the radium preparations produced by the Austrian Radiumpraeparatefabrik amounted to 14.1 gm., containing 2.647 gm. of pure radium chloride, valued at $214,900. Early in the present year radium bromide sold at $105 per milligram in Germany. In July, however, sales were made in Vienna at about half that price. As a reason for this decrease is attributed the fact that mesothorium, as well as radiothorium, have begun to be employed in place of radium, especially in medicine. Mesothorium more active than radium can be obtained at a cost of only $32 per milligram. Although the life of mesothorium is short, by mixing it with radium salts a long-lived preparation is said to be obtained.

ONE YEARS' COURSE IN SECONDARY AGRICULTURE.

By A. W. Nolan,
University of Illinois.

For many years to come most of the high schools teaching agriculture will be able to give only a one year's course. The problem arises as to what subject-matter to choose and what sequence to follow in presenting such a course. The idea of the seasonal sequence so well discussed in Brieker's *Teaching Agriculture in the High School,* seems to be the best principle to guide in the selection and presentation of the work in agriculture for a one year's course. The work falls into six large topics, and should be given in the order named: *Plant Studies* (matured plants), *Animal Studies, Farm Business and Life, Machine Studies, Soil Studies,* and *Studies in Conditions of Plant Growth.* Whatever the text chosen may be, the teacher should follow the above sequence, a detailed outline of which is here given.

First Semester's Work.

I. Plant Studies
- 1. Cereals
  - a. Wheat and oats
    - Varieties
    - Grading—Market standards
    - Proper seed-bed and planting-time
    - Place in rotation. Insect Enemies
    - Food values
  - b. Plant needs and how they are obtained,—have growing wheat plants to use for illustration of principles.
  - c. Corn
    - Some varieties
    - Selecting seed corn
    - Corn judging by score card
    - Storing seed corn
    - Food values
- 2. Meadows and pastures
  - a. Essentials of each
  - b. Some grasses
  - c. Improving
- 3. Legumes
  - a. Clover. How to grow and use
  - b. Alfalfa
  - c. Cow peas
  - d. Soy beans
- 4. Roots and Tubers
  - a. Beets
  - b. Potatoes
- 5. Weeds
  - a. Nature of injury
  - b. Identify common weeds of community

c. Collect and learn to identify at least the commonest impurities in clover and alfalfa seed
d. Some methods of eradication

6. Insect friends and enemies of plants
    a. Stages of insect life
    b. How insects injure plants
    c. Some principles in combating insects
    d. Some harmful farm insects
    e. Some beneficial farm insects
    f. Insects and human health
7. Plant diseases
    a. Molds
    b. Mildews
    c. Smuts
    d. Rusts
    e. How injury is done
    f. Some methods of control
    g. Bacteria
8. Fruit studies
    a. Encourage fruit-growing on farm
    b. Types of fruit
    c. Grading and judging apples
    d. Selecting trees to plant
    e. Laying out orchard and planting trees
9. Forestry
    a. Importance of the wood resource
    b. Agencies controlling forests
    c. Farmer's wood lot

II. Animal Studies

1. Value of animals in agriculture
2. Animal products and their use
    a. Milk, butter, cheese
    b. Eggs, meat, etc.
    c. Wool, hides, etc.
    d. Energy for work

    Lab. work—Babcock test
3. Animal types and breeds
    a. The horse
        Breeds of draft horses
        Draft and driving horses contrasted
        Anatomy of horse studied from chart or life
        Care and feeding of the horse
        Improving farm horses

        Exercise—judging horses
    b. Cattle
        Beef and dairy cattle contrasted
        Breeds of each type
        Name of external parts, and elementary judging of market grades
        Some rations for feeding cattle

        Exercises—judging cattle; problem in feeding rations
    c. Swine
        Identification of breeds of swine
        Practice in judging market types
        Feeding and housing swine
        Cholera and other hog ills

d. Sheep
Coarse and fine wooled breeds, contrasted for mutton and for wool
Elementary judging exercises
Some points in care and handling of sheep

e. Poultry
Common breeds of poultry, their identification and points of excellence
Improving the strain of farm chickens
Housing and feeding poultry
Exercises—incubator hatch

4. General census of farm animals of the neighborhood
5. Relation of farm animals to soil fertility

III. Farm Business and Life

1. Systems of farm accounts and bookkeeping
   a. Cost of production of an acre of each of common farm crops
   b. Cost of keeping a team of work horses
   c. Records of expenses and receipts from certain fields, or farm animals
2. Mapping home farms and showing plans of crop rotation
3. Studies in designs for farm buildings
4. Landscape designs for farmstead grounds and some suggested plantings
5. Farm life conveniences
6. Country life institutions and their improvement.

Practical work—Each pupil do some of the work as suggested above.

SECOND SEMESTER'S WORK.

IV. Machine Studies

1. Make a list of the common farm machinery with names of good types of each
2. Using plow as type, consider construction, relation and function of parts
3. Take down and set up one cultivating and one harvesting machine, if possible.
4. The gas engine
5. Points in the proper care of machinery
6. Cement construction on the farm
7. Students make reports on special topics relating to farm machinery

V. Soil Studies

1. Origin, types, and composition of soil
2. Physical relations of soil to water, air, temperature
   a. Drainage, its value
   b. Effects of lime
   c. Organic matter
   d. Tillage
3. Soil fertility and permanency
   a. Elements of plant food
   b. Sources and uses of each
   c. The limiting elements, and sources of each
   d. Use of fertilizers and manures
   e. The principles and practices for permanency
4. Critical study of the yields and farm practices of the neighborhood

VI. Conditions of plant growth

1. The developing plant is the central feature of these studies

2. Plant propagation
   a. Seeds
   b. Grafts
   c. Layering
   d. Cuttings
3. Relations of growing plants to
   a. Soil
   b. Moisture
   c. Temperature
   d. Light
   e. Plant food
   f. Cultivation
   g. Insect pests and diseases

Note.—In connection with the one year's course a series of home projects should be carried on by the students of the class as a part of the requirements of the course. For details of this work send to the Extension Department of the College of Agriculture, at Urbana, Illinois, for the circular on Home Projects for School Agriculture.

VOCATIONAL ASPECT OF REGIONAL GEOGRAPHY.[1]

By W. J. Sutherland,

President State Normal School, Platteville, Wisconsin.

Social progress is determined largely by physical environment. Usually, backward and indolent people inhabit the less productive regions of the world. Rich areas support progressive, enterprising people. Ignorant people often remain in backward conditions because of their inability to select those pursuits which can be used most advantageously for the betterment of their conditions. Education performs a very distinct function in guiding people in their selection and best use of the elements of their environment.

The "new geography" is quite fond of speaking of *controls* and *responses*. Certain it is that man cannot re-create his physical surroundings. The best he can do is to modify, in a small way, certain selected phases of his environment. He may add lime to acid soils, he may irrigate arid lands and make them productive; but even here it is plainly apparent that his physical environment is determining his *individual* activities. His labor is not from choice, but from necessity. The man who has to irrigate is handicapped in the race for prosperity.

The physiographic regions of any country furnish a most interesting study inasmuch as the physical conditions combine to give each region a personality and character that is often unique.

[1] Read before the Earth Science Section of the Central Association of Science and Mathematics Teachers, Des Moines meeting.

Especially noticeable in this respect, are the regions of the United States. As a result of certain combinations of physical forces, *sets* of conditions determine highly characteristic organic responses. Hence it is that plant and animal adaptations have become such interesting studies. Eliminate a single condition from any combination and likewise, through the operation of the law of the "survival of the fittest," the whole organic response is changed.

Man can do best for himself by working in harmony with Nature. Because sets of conditions fail to satisfy, men remove from one region to another with the hope of finding combinations better suited to their needs. The fact that men emigrate suggests at once some power to analyze conditions. The same intelligence, however, guides the new settler in the selection of industries adapted to his locality.

Society is, therefore, dependent on its physical environment for its existence. Industry is the link which connects man with his environment. Social progress depends upon the wise selection of human activities as determined by the physical advantages which a region offers. Reasonable returns for a given outlay of labor and capital make better homes, added advancement, and higher social attainments. Hence there is a direct connection between rich soil, generous rainfall, favorable temperature, and a cultured people. And yet, this statement suggests a wise use of "talents." This is another way of saying that the industries, the vocations of the people, are of supreme importance. Social progress depends upon the two factors, a favorable physical environment and an advantageous adjustment of human effort to that environment. Since man cannot annihilate or re-create his environment, it appears that the most important element entering into social progress is found in his industry or vocation. Hence, then, the three elements intermingle, i. e., man, industry, and environment; and, since man himself changes slowly in response to environmental conditions, it would seem, that in his industry, his vocation, lies the chief hope of progress, culture and independence. His industry he can control, his physical environment he can in a limited way modify, while he, himself, is changed only in the slow process of time in response to his vocation and environment.

The twentieth century renaissance in education had for its slogan "Education and Life." Abundant and complete life, however, are terms which signify social progress. The ever increasing complexity of modern life compels more delicate and carefully selected social and economic adjustments. If such adjustments

are unwise or imperfectly made, individuals are doomed to economic failure. Social progress and reform bear a direct relationship to economic progress. If this philosophy be true, it is of the highest importance that our education place due emphasis upon such subjects and phases of subjects as not only show the individual's dependence upon his physical environment, but which also permit of some direct application of his education and training in the use and appropriation of the elements of his environment.

The youth of the land are inclined to develop, dwell, and enter into the industrial pursuits of the neighborhood or locality in which they were born. The physical conditions surrounding them then are of first importance as related to their social welfare. Tradition is often a handicap and a drawback to progress. Economic prosperity and culture are the direct outgrowth of a wise use of natural resources. And, as already pointed out, modern life with its changing economy, demands the keenest and wisest of economic and physical adjustments. The rather easy conditions that obtained in pioneer life, when soils were exceedingly rich and had only to be "tickled with a plow to bring forth abundant harvests"; when valuable minerals often outcropped or were hidden in shallow pockets; and when indigenous fruits and game were abundant, have now given place to an intense stress and strain in which only keen intelligence and a high degree of personal initiative insure success. The social phase of life is greatly intensified through the interdependence of the constantly increasing number of social groups. It matters not what one's vocation in life may be, it is still true that his sustenance can be traced back ultimately to Mother Earth. The intricacy of modern social life becomes clearly apparent when one traces the necessities and luxuries of life back through a score of social groups and economic organizations to the original resourcefulness of the earth. Education becomes dynamic only when it impresses upon the student and future citizen his relationship to the social and physical worlds in which he dwells, and gives him some instruction concerning the activities through which he may hope to maintain himself in his struggle for existence. In short, popular education must give the student a general intellectual conception of the philosophy of modern life; then in addition to this, it must teach him how to get hold of some particular phase of the world's work, which, interpreted, means that his training must, in the light of twentieth century life, teach him to do something.

Rational geography is important because the progress of human industry already made determines an environment in which social conditions have developed. The spirit and atmosphere of the community react, in turn, upon the developing individual. He is mentally stimulated by the stress and strain, the hum and confusion of the characteristic industries of his region. It might seem that such contact with local environment might informally train the individual to meet successfully future obligations. Quite the opposite is true, however! "Familiarity breeds contempt," and the consciousness of the student is dulled by so frequent contact with existing conditions. Tradition, too, tends to guide his thinking in the currents of old channels. Nothing is more pertinent and truer than the fact that progress means a breaking away from old traditions and activities whenever keen insight has discovered, and practical experience verified, the advantages of a *new* way. "New occasions teach new duties." Even though there are individual pursuits as old as creation itself, even before the sun sets scientific progress and industrial development may show the world a new method through which original resources and raw materials can be prepared and brought with greater economy to the consumer. Hence it is that the geography of one's own region is, generally speaking, of first importance. It is true, also, that the rising generation will never attain success through informal education picked up from ancestors and neighbors. The vocational aspect of regional geography places due emphasis upon the study of industries, and since prosperity and culture are so directly dependent upon industry, it would seem that great importance attaches to this phase of geographical study.

To consider the vocational aspect of regional geography is to place emphasis upon the industries of the regions, for vocation or industry is the link which ties man to his environment. Sometimes the individual comes in *direct* contact with the resources of his environment, as in the case of the tiller of the soil. In this instance the industry called agriculture is the binding link. Again, the individual may come in contact with the resources of his environment in an *indirect* or *remote* way as, for example, when his activities are concerned not with his physical environment directly, but with some product of the earth brought to him by other social groups. Usually, however, in the study of geographic regions, men come in direct contact with natural resources. The production of rice, cotton, and sugar in the Gulf Plains, of wheat in the Red River Valley, of fruit in the Lake Plains, and of

corn in the Prairie Plains, are hackneyed examples of this truth. The hope of the future in any of these regions resides in improved methods of production as yet undiscovered.

The new geography has for its chief characteristic the idea of relationship. The rational idea becomes most prominent when we consider the vocational side of regional geography. Life responses together with inorganic resources always determine the industries of a region. Hence industry is a secondary response to physical environment. If we choose to go a step farther it may be said that the temperament, impulses, culture and ideals of the people are social responses to a larger environment made up of physical, industrial, and economic elements. The value of geographical study never appears in its fullness until pupils have caught something of this philosophy. Indeed, the rational or logical phase of earth science appears only when such sequences are recognized. The Red River Valley of the North becomes a highly suggestive idea to the pupil who can go back in his thinking to old Lake Agassiz; who has some notion of how the upward tilting of the earth's crust and the recession of the Great Glacier slowly drained this lake; how, as it drained, over its bed those deposits of fine silts were made; and how, in the present age, immense crops of wheat, barley and oats are produced in this, the world's richest soil. And yet again, the student who is taught to think well, may safely conclude that in such a region there will dwell on improved farms and in good homes, a progressive, intelligent, and reasonably cultured rural population. The Red River Valley, then, is synonymous with prosperity and enterprise. Students who have thus carefully developed this and similar subjects in general geography, must have made valuable acquisitions. If, however, we think of the students who live in a particular region, the vocational aspect of geography becomes still more apparent. In this case the students of the advanced grades should give special attention to the individual activities of their own particular region.

In the same way, corn, oats, and stock-raising become synonymous with the expression "The Prairie Plains." To still further support the foregoing arguments, it may be said that twenty years ago in the heart of the Corn Belt, it had not been discovered that deep cultivation, when the corn is large, is a positive injury to the crop. Although corn had been the chief crop for years, yet the farmers themselves were astonishingly slow in realizing that the long, spreading roots of the young plants were cut and torn

by deep cultivation. And not until the last decade has there been a scientific study of seeds. What more valuable study for a pupil who lives in the Corn Belt and who himself expects to become a farmer, than to make a careful and rather elaborate study of the production of corn. This would include something of the geological history explaining the formation of the soils, the climatic conditions most suitable to the growth of this cereal, a general knowledge of the plant itself, something of corn-judging and the selection of seed, the best time and methods of preparing the seed-bed, the most improved methods of cultivation, and the best uses of the crop itself to bring the largest returns to the producer. This may seem like the study of agriculture, but in a large sense, it is the vocational aspect of the Prairie Plains. The fine farm homes, the large barns, silos, granaries, filled to overflowing, the telephone, furnace heat, and the victrola are conditions and advantages gained by an intelligent use of the chief world resource, productive soil. The wiser and more expert the cultivation of the soil becomes, the larger the bank account and the greater the advantages of school and library and travel to the children whose good fortune it is to live in so wealthy a region. Vocational study and agricultural intelligence have steadily reduced the cost of tilling an acre of corn until even though the exhaustion of the soil fertility has naturally reduced the output, they have permitted the price of land to increase in market value two hundred per cent. If education and life are to become one and the same, instruction in geography must emphasize those phases of the subject which clearly point the way toward prosperity and culture.

In the new era of education application to human affairs determines the trend of learning. Applied science is at a premium! No longer are formal lessons taught without due regard to their social functions. Waterfalls are not studied as ends in themselves, but for the purpose of understanding their influence on the industrial and social worlds. Their study must take cognizance of results, the location of cities, the distribution of population, besides a half-hundred minor human activities —all of which radiate their influence into American civilization. So in any of the great regions, the most pertinent consideration is the industrial or vocational contact of humanity with its environment—for through this contact—any people or nation develops.

WOULD A SIPHON FLOW IN A VACUUM? EXPERIMENTAL ANSWERS.

By Ralph S. Minor,
University of California, Berkeley.

Present-day high school and college text-books in general physics (printed in English) are practically agreed upon two points concerning the siphon.

The first is that the effective driving force is proportional to the difference in length of the two arms of the siphon. The second point is that the siphon is an appliance which depends upon atmospheric pressure for its action and would not work in a vacuum, nor would it work if the length of the short arm were greater than the barometric height of the liquid used.

Let us consider a siphon whose arms have the lengths h_1—h_2 respectively, then "if we let H be the height of the column of liquid which the atmospheric pressure will support at the time and place of the experiment and d the density of the liquid, the pressure to the right on a plane through the highest point of the tube is $Hdg-h_1dg$ and the pressure to the left is $Hdg-h_2dg$ or the difference in pressure tending to produce flow is

$$(Hdg-h_1dg)-(Hdg-h_2dg) = (h_2-h_1)dg."^{1}$$

Three important conclusions may be drawn from this expression for the value of the driving force. First, that its magnitude depends directly upon the difference in length of the two arms of the siphon; second, that the direction of flow is out of the longer arm; and third, that its value is independent of atmospheric pressure.

The explanation of the siphon in many texts is, unfortunately, so worded and arranged that the reader is led to look upon this expression for the driving force as *proof* that the atmospheric pressure is essential to the action of the siphon. As Steinbrinck[2] has pointed out, the fallacy arises from the fact that we unconsciously carry into the result the idea of atmospheric pressure although, on account of its appearance with both positive and negative sign, it cancels out.

The only valid answers to the question as to the limit of height over which the siphon will work, or to the question as to whether or not it would work in a vacuum, are the answers of experiment —for experiment gives us two answers.

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[1] Reed and Guthe, College Physics, p. 94.
[2] C. Steinbrinck, Flora, Vol. 93, p. 130, 1903-1904.

Limiting Height for the Broken Siphon.

Making use of the admirable lecture demonstration suggested by Baker,[3] in which the siphon is broken at the top by means of a tube D through which the air may be removed, it is clear that in such a *broken* siphon the atmospheric pressure is continuously active in pushing the liquid up the short arm.

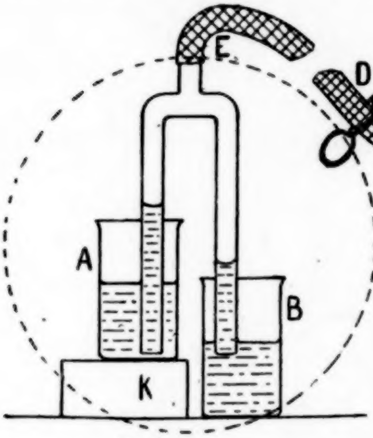

Figure 1.

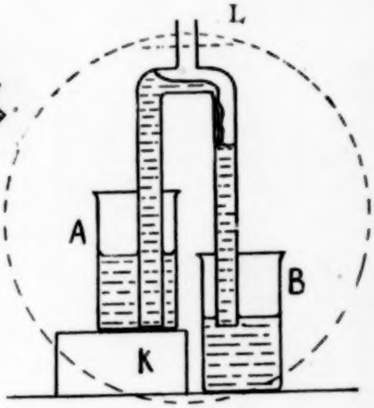

Figure 2.

The "dissected siphon" of Sinclair[4] also illustrates this point; as does the familiar so-called "vacuum siphon" in figure 3.

It is experimentally true that the limiting height of such a broken siphon is the barometric height of the liquid used.

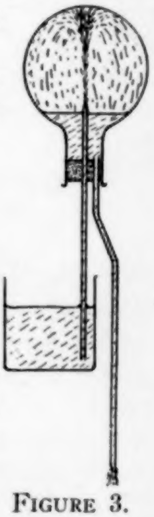

Figure 3.

Limiting Height for the Unbroken Siphon.

Suppose we use as our siphon a continuous tube of uniform bore. If we place a gauge alongside the siphon tube and cover both with a bell jar, we find, on exhausting the air with as little jarring as possible, that the siphon continues to act long after the mercury in the gauge has dropped below the bend in the siphon tube. The liquid colmun is now under tension and the long column of liquid pulls the short one over the bend in the tube. The limiting height is here evidently determined by the force of cohesion

[3] W. C. Baker, School Science and Mathematics, Vol. 7, p. 748, 1907.
[4] J. E. Sinclair, School Science and Mathematics, Vol. II, p. 416, 1911.

of the liquid which we know[5] to be many times greater than atmospheric pressure.

Owing to impurities in the mercury or roughness in the tube the column is often broken and the siphon will not start until the column is reunited.

A quick sharp tap on the tube will also break the column, and it seems quite likely that the jarring of the older type of air pump is the reason for the negative result described in the various editions of Carhart and Chute's *High School Physics*.

In presenting this experiment before the Pacific Coast Science Teachers' Association the following convenient method of starting the siphon *after* a bell jar was placed over it was used. Fasten the unfilled siphon with wax to a dish of mercury A (Figure 4), with the long arm just sealed by a little mercury in

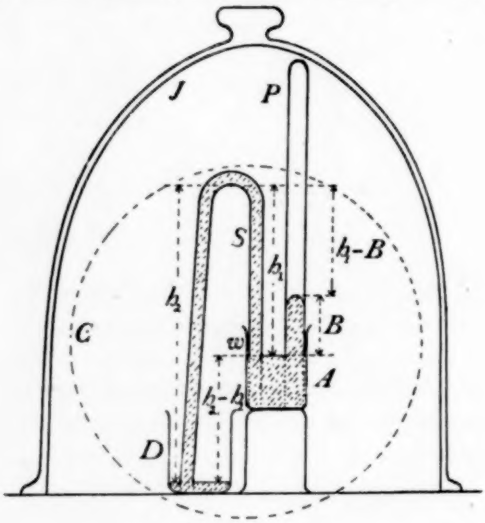

FIGURE 4.

a second beaker B. A carefully filled mercury gauge is placed alongside the siphon. Upon starting the pump, air is removed both from the bell jar and from the inside of the siphon as well. After the pressure has been considerably reduced, slowly admit air into the receiver; the mercury will then rise on both arms of the siphon but will reach the top on the short side first. As it flows over the bend it will drive the remaining air with it. If the receiver is then immediately connected with the pump again,

[5] Some 50 atmospheres for pure water. See account of Berthelot's experiment, Tait's Properties of Matter, p. 204, 5th Ed. and Ann. de Chim. et de Phys. XXX. p. 232. 1850.

the pressure will soon fall below h_1, while the siphon continues in action. Success has been obtained with tubes varying in diameter from 1 to 7 mm., and a length of arm as great as 46 cm. with a difference h_1—B varying from 10 to 30 cm. With tubes of large diameter, it is more difficult to drive out the remaining air as the mercury tends to flow around the bubble instead of pushing it out of the tube. In constructing the siphon care should be taken not to reduce the diameter of the tube in making the bends. The arrangement described permits of projection, the dotted line in the figure representing approximately the field of view on the screen.

FIGURE, 5.

The common siphon as used for the transference of liquids containing more or less air is a *broken* siphon. The unbroken siphon is of particular interest to botanists[6], who have made its action an essential part of one explanation of the rise of sap in trees.

Weinhold[7] has designed apparatus to illustrate the working of the cohesion siphon. In the form shown in Figure 5 it is now on the market[8] and readily enables one to show a mercury siphon in action with the length of the short arm some 110 centimeters. While it is difficult to hinder the breaking of such a long column of dry mercury it has been found that the addition of a little water overcomes this difficulty. The tube is sealed off after boiling the water to remove all air, the pressure inside being that of saturated water vapor. The siphon is started by holding it nearly horizontal. After it is in action it is carefully raised until the arms are vertical.

[6] Dixon and Joly, On the Ascent of Sap. Phil. Trans. Royal Soc., London, B1895, p. 563-576. Askenasy, Ueber das Saftsteigen, Verhandl. des Naturhist.-Mediz. Vereins zu Heidelberg, N. F. V., 1895.

[7] Weinhold, Zeitschrift fur den phys. und chem. Unterricht. Vol. 17, 1904, p. 152. Jahrbuch fur wissenschaft. Botanik, Vol. 42, pt. 4, pp. 585.

[8] Max Kohl, Catalog 50, No. 52664-52665.

A NEW JOURNAL.

There has recently come to our desk a new journal by the name of *Rural School Advocate*. This is a paper published in the interests of rural schools, and the aim of its promoters is to circulate it among teachers, trustees and pupils of all rural schools. There is a great field for this kind of work. The rural schools should have a journal promoting their interests and welfare, as well as those of the city. It will help greatly in the betterment of the rural school in all directions. We wish for it the greatest success.

VOCATIONAL ASPECTS OF GEOLOGY.[1]

By Professor R. D. Salisbury,

Head of the Department of Geography, University of Chicago.

Geology has to do chiefly with the solid parts of the earth, but air and water are also parts of the earth, and so fall, in some sense, within the field of geology. It follows therefore that all vocations which are based on the inorganic materials of the earth, are dependent, directly or indirectly, on geology. Furthermore, since plants grow in the materials of geology and since animals are, in the last analysis, dependent on plants, it is clear that all industries connected with plant and animal life are to some extent connected with geology.

More than half the people of our country get their living out of what may be called geological material; that is out of the soil, mines, quarries, etc. For the best results, it is important that they know geology, for it stands to reason that they can get better results, if they understand their materials. To know how to utilize soil to the best advantage, its composition, its texture, and its lie must be not only known, but the significance of these several points must be thoroughly comprehended. Only thus can it be known what crops can be raised most profitably, and how best to fit the soil for desired crops. It is important too, to know the nature of the subsoil, and of the rock beneath, for these things have an important bearing on under-drainage. It is true that men may go on the experience of others, even without knowing the reason why; but who are the others, by whose experience they are to be guided? Clearly the leaders are the men who gain most, but in this matter all may be leaders. If there are but few, why not your pupils and mine? It is only by intelligent study of soils, and a thorough comprehension of the significance of their composition, texture, and lie, taken in connection with the climate in which they occur, that men can best know how to use soil and water, which form the basis for the most fundamental industry of the world.

Comprehension of geologic materials and their uses, too, are of extreme importance in the making of good roads, in importance second only to good crops.

To miners and quarrymen knowledge of geology is at least equally important. The mucker in the mine may do very well

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[1] Synopsis only of a paper read before the Earth Science Section of the Central Association of Science and Mathematics Teachers, Des Moines meeting.

without geology; but he is likely to remain a mucker. The man who comprehends may, with the proper personal qualities, rise to a foremanship or a managership. Quarrymen call in geologists when they get into trouble, to tell them how to proceed. Miners call in geologists to advise with them with reference to future development. A very large number of men today gain a comfortable livelihood as advisers for mining enterprises of one sort and another, in our own country and in foreign lands. The call for such men is large both at home and abroad, and is likely to increase rather than decrease.

As a preparation therefore for the industries which support more than half the people of our country, geology is one of the most fundamental studies. We owe it to our pupils to give them at least the possibility of entrance into these large and attractive fields.

WHY ARE SOME CHILDREN CROSS-EYED?

The general public has many false ideas concerning this unsightly defect and consequently many parents are prone to neglect it because of the hope or the belief that the child will "outgrow it."

Were the real cause and the consequence of neglect of this condition more generally known and accepted, great benefit might result to many unfortunate children and their lives made happier. It is not generally known that in the majority of squinting eyes, blindness results to a greater or less degree unless early attention be given them.

The primary cause in most children who have this defect is the lack of the power of combining the images seen by the two eyes into one. This faculty has been lost or has not been developed with the growth of the child. Its development may have been interfered with by a difference in the two eyes, one being far-sighted, the other near-sighted, or there may be other differences which interfered with harmonious action. The child cannot focus both eyes on an object at the same time, so in order to avoid the discomfort or strain of effort, the weaker eye gives up and crosses in order to avoid the embarrassment of double vision, which would otherwise occur.

Soon this habit becomes fixed, and permanent squint is brought about. The squinting eye, not receiving any stimulus from use, gradually loses the seeing faculty and partial blindness is the result.

This loss of vision from disuse is more rapid in the very young than in older children. If a child begins to squint at the age of six months, and has good vision in each eye, the squinting eye, if neglected, will become blind in eight to ten weeks. If he does not begin to squint until he is eighteen months old the progress of the blindness will not be so rapid, but he will be blind in the squinting eye in five or six months.

If he does not begin to squint until the age of three years he seldom loses the power of vision in less than a year thereafter. After the age of six years, the danger is not so great, and the child may retain it to some extent. Every child who shows symptoms of squint should have early attention if sight is to be preserved or the deformity prevented.

PROBLEM DEPARTMENT.

BY E. L. BROWN,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

361. *Proposed by Norman Anning, Chilliwack, B. C.*

Show, without dividing, that $x^4-x^3+x^2-x+1$ is a factor of $x^{44}-x^{33}+x^{22}-x^{11}+1$.

I. *Solution by A. M. Harding, Fayetteville, Arkansas, and Elmer Schuyler, Brooklyn, N. Y.*

We have $x^5+1 = (x^4-x^3+x^2-x+1)(x+1)$.

Hence the roots of $x^4-x^3+x^2-x+1 = 0$ are a_1, a_2, a_3, a_4.

Where $a_1^5 = a_2^5 = a_3^5 = a_4^5 = -1$.

Now $x^{44}-x^{33}+x^{22}-x^{11}+1 = x^{40}\cdot x^4-x^{30}\cdot x^3+x^{20}\cdot x^2-x^{10}\cdot x+1$.

Let $x = a_1$ and we obtain $a_1^4-a_1^3+a_1^2-a_1+1 = 0$. Since a_1 is a root of $x^4-x^3+x^2-x+1 = 0$.

Hence the given expression is divisible by $(x-a_1)$.

Likewise it can be shown that it is divisible by $(x-a_2)$, $(x-a_3)$, $(x-a_4)$ and hence by

$$(x-a_1)(x-a_2)(x-a_3)(x-a_4) \text{ or } x^4-x^3+x^2-x+1.$$

II. *Solution by F. Eugene Seymour, Trenton, N. J.*

Solution:

$$x^4-x^3+x^2-x+1=\frac{x^5+1}{x+1}\text{ ; and } x^{44}-x^{33}+x^{22}-x^{11}+1=\frac{x^{55}+1}{x^{11}+1}.$$

The question of divisibility then reduces to proving that

$$\frac{x^{55}+1}{x^{11}+1} \div \frac{x^5+1}{x+1} \text{ or } \frac{x^{55}+1}{x^{11}+1}\cdot\frac{x+1}{x^5+1}$$

is an integral expression. Now we know that $x^{55}+1$ is divisible by $x^{11}+1$ and also by x^5+1. And since these two divisors have only $x+1$ in common then $(x^{55}+1)(x+1)$ surely contains the product and the result is an integral expression.

III. *Solution by Proposer.*

$x^4-x^3+x^2-x+1$ is a factor of $x^{44}-x^{33}+x^{22}-x^{11}+1$ if all the roots of $x^4-+\ .\ .\ .\ =0$ are roots of $x^{44}-+\ .\ .\ .\ =0$.

Now $x^4-x^3+x^2-x+1=\dfrac{x^5+1}{x+1}$.

Hence the roots of $x^4-x^3+x^2-x+1 = 0$ are those of $x^5+1 = 0$, excepting $x = -1$.

$$x^5+1 = 0,$$
$$x^5 = -1 = e^{i\pi},$$
$$x = e^{i\frac{\pi}{5}},\ e^{i\frac{3\pi}{5}},\ \underline{\underline{e^{i\frac{5\pi}{5}}}},\ e^{i\frac{7\pi}{5}},\ e^{i\frac{9\pi}{5}}.$$

$\therefore$ the roots of $x^4-x^3+x^2-x+1 = 0$ are $x = e^{ip\pi}$ where p is equal to

$$1/5,\quad 3/5,\quad 7/5,\quad 9/5.$$

And the roots of $x^{44}-x^{33}+x^{22}-x^{11}+1 = 0$ are given by $x^{11} = e^{iq\pi}$ or

$$x = e^{iq\pi} \text{ where } q = \frac{2k+p}{11}\ (k = 0, 1, 2, 3\ .\ .\ .\ 10;\ p = 1/5, 3/5, 7/5, 9/5).$$

When $p = \frac{1}{5}$, $q = \frac{1}{55}$, $\underline{\frac{11}{55}}$, $\frac{21}{55}$ . . . . $\frac{101}{55}$.

When $p = \frac{3}{5}$, $q = \frac{3}{55}$, $\frac{13}{55}$, $\frac{23}{55}$, $\underline{\frac{33}{55}}$ . . . $\frac{103}{55}$.

When $p = \frac{7}{5}$, $q = \frac{7}{55}$, $\frac{17}{55}$ . . . $\underline{\frac{77}{55}}$ . . . $\frac{107}{55}$.

When $p = \frac{9}{5}$, $q = \frac{9}{55}$, $\frac{19}{55}$ . . . $\underline{\frac{99}{55}}$, $\frac{109}{55}$.

The four values of p are found among the forty-four values of q.

Therefore $x^4-x^3+x^2-x+1$ is a factor of $x^{44}-x^{33}+x^{22}-x^{11}+1$.

362. *Proposed by Orville Price, Denver, Colo.*

If
$$\frac{b^2+c^2-a^2}{2bc}+\frac{c^2+a^2-b^2}{2ca}+\frac{a^2+b^2-c^2}{2ab}=1,$$
show that each of two of the three fractions must be equal to 1, and the other to -1.

Solution by Nelson L. Roray, Metuchen, N. J., and Edward R. Wicklund, Litchfield, Minn.

If
$$\frac{b^2+c^2-a^2}{2bc}+\frac{c^2+a^2-b^2}{2ca}+\frac{a^2+b^2-c^2}{2ab}=1,$$
to show that each of two of the three fractions must be equal to 1 and the other equal to -1.

$$a(b^2+c^2-a^2)+b(c^2+a^2-b^2)+c(a^2+b^2-c^2) = 2abc.$$
$$(ab+c^2-a^2+ab+b^2)(a+b)-c(2ab+c^2-a^2-b^2) = 0.$$
$$(b+c-a)(c+a-b)(a+b-c) = 0.$$

The given relation holds if any one of the quantities a, b, c is equal to the sum of the other two.

Suppose $b+c = a$.

$$\begin{array}{ccc} b+c=a & b=a-c & a-b=c \\ b^2+c^2-a^2=-2bc & a^2+c^2-b^2=2ac & a^2+b^2-c^2=2ab \\ \dfrac{b^2+c^2-a^2}{2bc}=-1 & \dfrac{c^2+a^2-b^2}{2ca}=1 & \dfrac{a^2+b^2-c^2}{2ab}=1 \end{array}$$

NOTE.—The problem is not true without restrictions.

If $a = b$ and $c = 0$, or $a = c$ and $b = 0$, or $b = c$ and $a = 0$, or $a = b = \infty$ and c finite, or $b = c = \infty$ and a finite, or $a = c = \infty$ and b finite, the given equation is true, as is readily seen by substitution and evaluating the result.

Suppose a, b, and c sides of a triangle then the given equation is evidently
$$\cos A + \cos B + \cos C = 1.$$
or
$$\sin A/2 \sin B/2 \sin C/2 = 0 \quad . \quad . \quad . \quad M.$$

Which shows no triangle is possible that satisfies the given equation.

1. No triangle is possible if a, b, and c are finite and unequal when $a = b+c$, or $b = a+c$, or $c = a+b$.

2. Also no triangle is possible if c is finite and a and b are parallel, that is, if $a = b = \infty$. One of the conditions derived from equation M is
$$C = 0 \text{ and } A+B = 180^\circ;$$
that is a and b are parallel.

3. Also no triangle is possible if $c = 0$ and $a = b$. In this case a and b may be either infinite or finite.

Thus condition 1 satisfies the problem as stated while conditions 2 and 3 show that the given equation is true without two of the fractions being equal to $+1$ and one to -1.

Geometry.

363. *Proposed by W. T. Harlow, Portland, Oregon.*

From the middle point of one of the edges of a regular tetrahedron a

fly descends by crawling around the tetrahedron, and reaches the base at the point where the edge meets the base. Find at what point the fly must cross the other edges if its path is everywhere equally inclined to the plane of the base. (Phillips & Fisher's Geometry, Problem No. 175, Page 482.)

Solution by D. J. da Silva, New York City.

Let V—ABC be the regular tetrahedron. Let $A_1B_1C_1A$ be the path of the fly; A_1 the midpoint of VA, B_1 on VB and C_1 on VC. Let $VA = a$, $VB_1 = b_1$, $VC_1 = c_1$. Then $VA_1 = a/2$.

From similar triangles VA_1B_1, VB_1C_1, VC_1A, we have

$$\frac{a}{2b_1} = \frac{b_1}{c_1} = \frac{c_1}{a}.$$

$$\therefore\ 2b_1^2 = ac_1, \text{ and } a^2 = 2b_1c_1 \text{ or } c_1 = \frac{a^2}{2b_1}.$$

$$\therefore\ 2b_1^2 = \frac{a^3}{2b_1} \text{ or } b_1 = \frac{a}{2}\sqrt[3]{2}. \qquad \therefore\ c_1 = \frac{a}{2}\sqrt[3]{2^2}.$$

Suppose the fly reaches A after crawling around the tetrahedron twice. In this case let its path be $A_1B_1C_1A_2B_2C_2A$. Let $VA_2 = a_2$, $VB_2 = b_2$, $VC_2 = c_2$.

Again from similar triangles, we have

$$\frac{a}{2b_1} = \frac{b_1}{c_1} = \frac{c_1}{a_2} = \frac{a_2}{b_2} = \frac{b_2}{c_2} = \frac{c_2}{a}. \qquad (1)$$

From (1) we find

$$c_2 = \frac{a}{2b_1}\cdot a = \frac{a^2}{2b_1}.$$

$$b_2 = \frac{a}{2b_1}\cdot c_2 = \frac{a^3}{2^2b_1^2}.$$

$$a_2 = \frac{a}{2b_1}\cdot b_2 = \frac{a^4}{2^3b_1^3}.$$

$$c_1 = \frac{a}{2b_1}\cdot a_2 = \frac{a^5}{2^4b_1^4}.$$

$$b_1 = \frac{a}{2b_1}\cdot c_1 = \frac{a^6}{2^5b_1^5}.$$

Therefore

$$b_1 = \frac{a}{2}\sqrt[6]{2}$$

$$c_1 = \frac{a}{2}\sqrt[6]{2^2}$$

$$a_2 = \frac{a}{2}\sqrt[6]{2^3}$$

$$b_2 = \frac{a}{2}\sqrt[6]{2^4}$$

$$c_2 = \frac{a}{2}\sqrt[6]{2^5}$$

Suppose the fly reaches A after crawling around the tetrahedron n times. In this case we find

$$b_1 = \frac{a}{2}\sqrt[3n]{2}$$

$$c_1 = \frac{a}{2}\sqrt[3n]{2^2}$$

$$a_2 = \frac{a}{2}\sqrt[3n]{2^3}$$

etc.

364. *Proposed by S. F. Parson, DeKalb, Ill.*

A mile race track has two intersecting "straight-ways" each 1000 feet in length and tangent to the circular arc which completes the mile. Required the radius of the arc.

Solution by William W. Johnson, Cleveland, Ohio, and Walter C. Eells, Tacoma, Wash.

Let AP and BP be the two tangent "straight-ways" intersecting in the point P, and ACB the arc composing the race track; O the center, and OB the radius of the arc.

Let $BOP = \theta$, and $OB = r$. By the conditions, $AP = BP = 1000$ feet, and length of arc $ACB = (1 \text{ mile minus } 2000 \text{ feet}) = 3280$ feet.

Length of arc ACB $= r(2\pi - 2\theta) = 3280$, or $r(\pi - \theta) = 1640$. (1)

$$\text{Also, } r = \frac{BP}{\tan\theta} = \frac{1000}{\tan\theta}. \qquad (2)$$

Eliminating r between (1) and (2), we obtain

$$\theta + 1.64 \tan\theta = \pi.$$

Solving this equation by successive approximations, we find

$$\theta = 53^\circ\ 24'\ 48.72''.$$

Substituting the tangent of this angle in (2), we find

$$r = 742.3 \text{ feet.}$$

CREDIT FOR SOLUTIONS.

357. O. N. Horner, W. Moffett Smith. (2)

361. Norman Anning, A. M. Harding, R. M. Mathews, H. C. McMillen, Nelson L. Roray, Elmer Schuyler, F. Eugene Seymour. (7)

362. Norman Anning, A. M. Harding, Walter C. Eells, H. C. McMillen, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, F. Eugene Seymour, Edward L. Wicklund. (9)

363. Norman Anning, D. J. da Silva, Ward D. Jordan, Nelson L. Roray, M. G. Schucker, Elmer Schuyler. (6)

364. Norman Anning, Walter C. Eells, Daniel Kreth, Nelson L. Roray. (4)

Total number of solutions, 28.

PROBLEMS FOR SOLUTION.

Algebra.

376. *Proposed by A. C. Smith, Denver, Colorado.*

If m and n are roots of the equation $ax^2+bx+c = 0$, find the value of $m^4+m^2n^2+n^4$.

377. *Proposed by H. E. Trefethen, Waterville, Me.*

If in the equations, $x^2+xy+y^2 = a$, $x^2+xz+z^2 = b$, $y^2+yz+z^2 = c$, a, b, c are in arithmetical progression, then also are x, y, z; and conversely, if x, y, z are in arithmetical progression, so also are a, b, c.

Geometry.

(Erratum.) (369.) This should read: Given the circle O, and the two points A and B without the circle. Determine a point C on the circle such that the lines AC and BC make *equal* angles with the tangent to the circle at the point C.

378. *Proposed by J. H. Smith, San Francisco, California.*

By elementary methods, prove that the altitude of the maximum cylinder that can be inscribed in a right circular cone is equal to one-third the altitude of the cone.

379. *Proposed by Norman Anning, Chilliwack, B. C.*

To construct, with straight-edge only, the join of a given point to the inaccessible point of intersection of two given straight lines.

380. *Proposed by Editor.*

Let AB and CD be two parallel chords of the circle O. Show how to inscribe a circle in the segment ABDC tangent to the two chords and the given circle.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

130. *Proposed by C. A. Perrigo, Dodge, Neb.*

(This question was propounded by Dr. E. R. Hedrick during an address before the Nebraska State Teachers' Association, Nov. 5-7, 1913.)

Since 100 degrees C. equals 212 degrees F., why does not —100 degrees C. equal —212 degrees F.?

131. *Proposed by A. Bjorkland, Appleton, Wis.*

A clock-winding magnet is to be re-wound so that it may be supplied with current at 32 instead of 8 volts. If the original winding consists of 120 feet (700 turns) of No. 25 D. C. C. copper wire, of what must the new winding consist?

132. *From Hale's Calculations of General Chemistry, page 103, No. 162.*

12 grams of an alloy of aluminum and zinc (containing 33⅓ per cent of zinc) were placed in a vessel containing 180 grams of hydrochloric acid (35 per cent H. Cl). What volume of hydrogen, at standard conditions, was liberated? (Ans. 11,290 cc.)

133. How much time should have been allowed for the answering of the following examination? (The class was a junior class in high school which had studied Physics for three months.)

PHYSICS (December, 1913).

1. (a) Define motion, velocity, acceleration.
(b) State the laws and formulas for uniformly accelerated motion.
(c) The record for the mile run is 4 min. 17¾ sec. What is the average speed of the runner in feet per second?
2. (a) State Newton's Laws of Motion.
(b) State and explain the principle of the *parallelogram of forces.*
(c) What property of air makes it possible for a bird to fly? Explain
3. (a) Define *moment of force.* State *principle of moments.*
(b) A loaded wagon weighing 2000 kgm. is crossing a bridge 40 m. long. When it is 10 m. from one side, how is the weight divided between the abutments of the bridge?
4. (a) State the *law of gravitation.*
(b) A stone is dropped from a bridge 150 feet high. How soon will it strike the water?
(c) A body falls freely for 10 seconds. How far does it travel?
5. (a) Define *work, energy.*
(b) How many foot pounds of work are done in carrying 100 pounds of brick to the top of a building 42 feet high?
6. (a) Name the six simple machines.
(b) Give the *mechanical advantage* for any four of them.
(c) Distinguish between *mechanical advantage* and *efficiency.*
7. (a) What is the pressure in pounds per square inch on the bottom of a boat drawing 20 feet of water? [1 cu. ft. of water weighs 62.5 lb.]
(b) The dimensions of a piece of oak are 4x6x2 cm. It weighs 36 gm. What is its density?
8. (a) Explain with sketch the operation of a suction pump.
(b) Can a liquid be siphoned from an air-tight barrel? Why?

9. Outline the physical principles involved in pumping up an automobile tire.

134. What do you think of the following examination paper as representing the work in Physics for the first semester in the freshman class of one of the largest universities in the country?

ELEMENTARY PHYSICS (February, 1911).

1. What weight would stretch a coiled spring two inches if ¼ lb. stretches it ⅛ inch? What practical use is made of such a device?
2. How does a liquid differ from a solid? How do you explain floating of solids in liquids?
3. What do you mean by pitch of a sound? Explain how the pitch of a vibrating string may be raised one octave.
4. How does the direction of a beam of light change in passing from water or glass to air? Give a diagram.
5. Describe carefully some experiment in electricity or heat in which you measured some physical constant. Show just how results were derived from your data.

Solutions and Answers.

120 *Proposed by H. C. McMillin, Washington, Kans.*

Find the theoretical inclination of the horizontal for a projectile having an initial velocity of 2,400 feet per second in order that the range may be 12,000 yards.

Solution by C. A. Perrigo, Dodge, Neb.

The formula for range of a body projected with a velocity v at an angle a with the horizon is $R \doteq \frac{v^2 \text{ Sin } 2a}{g}$; see SCHOOL SCIENCE AND MATHEMATICS, issue of March, 1912, page 237.

Substituting values $36000 = \frac{2400^2 \cdot \sin 2a}{g}$

Solving $\sin 2a = .201$.

Then $a = 5° \ 47' \ 50''$.

122. Specific Heat is .03. *Answer.*

123. Volume is 476.4 cc. *Answer.*

124. Weight oxygen is 97.9 gm. There are $97.9 \div 32 = 3.06$ gram-molecules. *Answer.*

ARTICLES IN CURRENT PERIODICALS.

American Botanist for November; *Joliet, Illinois; $1.00 per year, 25 cents a copy:* "The North American Cypripediums," Grace G. Niles; "The Production of New Forms in Rudbeckia," Willard N. Clute.

American Naturalist for January; *Garrison, N. Y.; $4.00 per year; 40 cents a copy:* "A Genetic Analysis of the Changes Produced by Selection in Experiments with Tobacco," Professor E. M. East and H. K. Hayes; "Gynandromorphous Ants, Described During the Decade, 1903-1913," Professor William Morton Wheeler.

American Forestry for November; *Washington, D. C.; $2.00 per year, 20 cents a copy:* "The Fire Protection of the U. S. Forest Service," Agnes C. Laut; "Development of Fire Protection in the States," J. Girvin Peters; "Greatly Reduced Fire Losses For 1913," E. T. Allen; "What Has Been Accomplished in Fire Protection on the National Forests," H. E. Woolley; "Dynamite in Forest Fire Fighting," Warren H. Miller; "In Reconnais-

sance Camp," A. G. Jackson; "The Conservation of Water," Walter McCulloh; "Waste in Cutting Timber," R. C. Bryant; "Water Laws, State and National," Charles N. Chadwick.

American Mathematical Monthly for December; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year:* "Number Systems of the North American Indians," W. C. Eells; "The Curve of Light on a Corrugated Dome," W. H. Roever; "On Certain Diophantine Equations Having Multiple Parameter Solutions," R. D. Carmichael; "The Cube Root of a Binomial Surd," Arthur C. Johnson.

Condor for November-December; *Eagle Rock, Los Angeles Co., Cal.; $1.50 per year:* "Notes on the Eggs of the North American Limicolae," Herbert Massey; "Some Further Notes on Sierran Field-Work" (with four photos by Oluf J. Heinemann), Milton S. Ray; "Identification by Camera" (with two photos), William L. Dawson; "Some Curious Nesting Places of the Allen Hummingbird on the Rancho San Geronimo," Joseph Mailliard; "The Birds of San Martin Island, Lower California" (with six photos by the author), Howard W. Wright; "Preliminary Report Upon the Disease Occurring Among the Ducks of the Southern San Joaquin Valley During the Fall of 1913" (with eleven photos by the author and one diagram), Frank C. Clarke.

Education for December; *120 Boylston Street, Boston; $3.00 per year, 35 cents a copy:* "The Need of Better Preparation of Teachers for Secondary Schools," Elmer E. Brown; "Present Facilities for the Training of Secondary School Teachers in New England," Raymond McFarland; "Aims and Standards for Preparation of Secondary School Teachers in New England," William Orr; "Measurements of Efficiency in College," Abbott L. Lowell; "Measurements of Efficiency in Elementary and Secondary Schools," Frank E. Spaulding; "Is Scientific Accuracy Possible in the Measurement of the Efficiency of Instruction," George D. Strayer.

Educational Psychology for December; *Warwick and York, Baltimore, Md.; $1.50 per year, 20 cents a copy:* "Preliminary Study of the Effect of Dental Treatment upon the Physical and Mental Efficiency of School Children," Emma Kohnky; "Experimental Researches on Learning to Spell" Part II, W. H. Winch; "Is Myopia Inherited or Acquired," Christian A. Ruckmich.

Journal of Geography for December; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "Is the Increasing Control of Man Over Nature Making Him Independent of Geographical Conditions?" George G. Chrisholm; "The Climate of Florida in Relation to the State's Most Important Industry," J. W. Hubbard; "Industries as Studies for High School Pupils in a Commercial Geography Course," Sumner W. Cushing; "Geographical Institutions in Germany," Joseph Partsch; for January—"Material on Geography Which May Be Obtained Free or at Small Cost," Mary J. Booth.

Nature-Study Review for December; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Goldfish and Geography," Anna Botsford Comstock; "Natural Nesting Sites as a Factor in Bird Abundance," C. W. Finley; "The Fuel Woods of the Farm," James G. Needham; "Physical Nature-Study for the Elementary School," Wm. T. Skilling; "The Glass Snake," J. T. Buchholz.

Photo-Era for January; *383 Boylston Street, Boston; $1.50 per year; 15 cents a copy:* "A Winter Vacation in New Hampshire," Phil M. Riley; "Coloring Photographs with Oil-Colors," Lehman Wendell; "American School-Boys' Tour in Europe," James R. Starr; "Persistence of Vision and Its Relation to Kinematography," Robert T. Haines; "Group-Portraiture" (illustrations by the author), C. E. Kelsey.

Physical Review for December; *Ithaca, N. Y.; $6.00 per year, 50 cents a copy:* "A Powerful Röntgen Ray Tube with a Pure Electron Discharge," W. D. Coolidge; "The Change in the Elasticity of a Copper Wire with Current and External Heating," H. L. Dodge; "The Effect of Space Charge and Residual Gases on Thermionic Currents in High Vacuum," Irving Langmuir; "The Sensibility Curves for Selenium; a New Sensibility-Wave-Length Maximum and a New Principle," F. C. Brown and

L. P. Sieg; "On the Nature of the Volta Effect," Fernando Sanford; "The Magnetic Susceptibility of Gases," W. P. Roop.

Popular Astronomy for January; *Northfield, Minn; $3.00 per year; 15 cents a copy:* "Monthly Report on Mars," William H. Pickering; "Johann Nepomuk Krieger" (with plates, II-IV); "Note on Two Spectroscopic Binaries," Edwin B. Frost; "Methods of Receiving the Arlington Wireless Time Signals and Computing the Longtitude," William F. Rigge; "The Radial Velocity of the Andromeda Nebula," V. M. Slipher; "The Total Eclipse of 1914," David Todd; "Radial Velocities and Preferential Motions," R. H. Curtiss; "Astronomical Phenomena in 1914."

Popular Science Monthly for January; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "The Mechanism of Heredity an Indicated by the Inheritance of Linked Characters," T. H. Morgan; "The Present Status of Cancer Research," Leo Loeb; "Psychology: Science or Technolgy," E. B. Titchener; "The Illinois System of Permanent Fertility," Cyril G. Hopkins; "Chabaneau: an Early Worker on Platinum," Jas. Lewis Howe; "The Biologist's Problem," T. D. A. Cockerell; "A Comparison of White and Colored Children Measured by the Binet Scale of Intelligence," Josiah Morse; "The Struggle for Equality in the United States," Charles F. Emerick; "The Democratic Organization of a State University," Joseph K. Hart.

Psychological Clinic for December; *Woodland Ave. and 36th St., Philadelphia; $1.50 per year; 20 cents a copy:* "Children with Mental Defects Distinguished from Mentally Defective Children," Lightner Witmer; "Clinical Psychology Adversely Criticized," R. H. Sylvester; "Some Thinking Processes of Grade Children," C. E. Benson.

School Review for January; *University of Chicago Press; $1.50 per year, 20 cents a copy:* "The Organization of a Large High School," John A. Bole; "Co-operation Between the National Education Association and the National Society for the Promotion of Industrial Education," Robert J. Fuller; "The Effect of Conditions of Schoolroom Heating and Ventilating on Schoolroom Attendance," Charles H. Keene, M. D.; "Some Experiments in High-School Instruction," I. M. Allen.

School World for December; *Macmillan and Company, London, Eng.; 7s. 6d. per year, 6 p. a copy:* "Practical Work in the Teaching of Elementary Mathematics," S. Lister; "Public School Libraries," S. P. B. Mais; "Some Points for Science Teaching from the History of Physics," F. Hodson.

Zeitschrift für den Physikalischen und Chemischen Unterricht for November; *Prof. Dr. F. Paske, Berlin-Dahlem, Friedbergstrasse 5; 6 numbers, $2.88, M12 per year:* "Einfache theoretische und experimentelle Demonstration der Coriolisschen Kraft," O. Wiener; "Ein neuer Demonstrationsapparat zur bequemen und genauen Bestimmung des mechanischen Wärmeäquivalents," W. Boy und J. Grebler; "Demonstration der chemischen Reaktionsgeschwindigkeit mittels des Galvanometers," M. Centnerszwer; "Freihandversuche zu wichtigen Gesetzen des galvanischen Stroms," P. Luckey; "Ein Solenoidgalvanoskop für Schülerübungen," F. Stein; "Eine zerlegbare Fallrinne mit elektrischen Kontakten," B. Kolbe; "Einfaches Monochord zur akustischen Bestätigung des Parallelogrammsatzes," Fr. C. G. Müller; "Wurf aus bewegtem Körper," Fr. Queiber; "Die fallende Katze," F. Schicht; "Eine einfache Demonstrationslippenpfeife," F. Queiber; "Eine Verbesserung der Brennpunktseigenschaften von Hohlspiegeln," F. Berger; "Über die Schaltung galvanischer Elemete," W. Leick; Vorlesungsversuch zur Chlorierung des Eisens," O. Ohmann; "O. Praetorius, Zur Reflexion am Ende von Röhren; Wirkung des Schleiftaues beim Luftballon," Versuche mit einfachen Mitteln.

Jumulong Mangloc is the highest point in the island of Guam, our smallest individual Pacific island possession. According to a chart published by the United States Geological Survey, it is 1,274 feet above the sea.

PRELIMINARY REPORT OF THE COMMITTEE ON A UNIFIED HIGH SCHOOL SCIENCE COURSE.

The following report was presented at the Des Moines, Iowa, meeting, of the Central Association of Science and Mathematics Teachers in November, 1913, the report being presented by Mr. James H. Smith of the Austin High School, Chicago.

For several years there has been more or less discussion regarding the need of better unification in aims and practices in science teaching, and better unification in the content of the science courses of the different years of the high school. At the meeting of the Association held at Evanston, Illinois, in November, 1912, a committee was appointed to consider the question and bring in whatever report the committee might wish to present. Numerous discussions between members of the committee and many other science teachers were held throughout the year, though most of the work of the committee members with one another was carried on by means of correspondence. While the report is concurred in by most of the members of the committee, it is not fully concurred in by all, as will probably appear in discussions to follow in the pages of SCHOOL SCIENCE AND MATHEMATICS and other magazines. It is earnestly hoped that all persons interested in high school science will consider whether they have not some pertinent comment which should be made in printed form so that others may have the benefit of their ideas. Particular consideration is therefore asked to the first section of the report.

I. THIS REPORT IS PRELIMINARY AND IS PRESENTED AS A BASIS FOR DISCUSSION.

So many factors are involved in the high school science situation, that the committee has decided to present a provisional report. Such a report should be discussed verbally and in the pages of SCHOOL SCIENCE AND MATHEMATICS and other magazines. It is hoped by this means to secure the fullest expression of opinion and report of experience from different parts of the country and from persons of various kinds of interest in science teaching. A report prepared by one committee can scarcely be expected to embody the ideas of all, and frank and direct discussion in meetings and in the pages of the magazine seems the best means of consideration of the report.

II. PRESENT CONDITIONS OF HIGH SCHOOL SCIENCES.

As the various sciences have become differentiated and developed, most of them have been introduced into the high school curriculum in one or more parts of the country. Each science has merit else it would not stand as a science. Its advocates see opportunity for the science, and opportunity for accomplishment of good by its use in high schools and thus a place is found for it. In this way one subject after another has gained entrance into the curriculum until often eight different science subjects, and sometimes even twelve are found within the high school of a single state.

These numerous sciences are contending with one another for a place in the high school, instead of presenting a demonstration of the efficiency of unified science in the high school. The need of unification of sciences is apparent to anyone who has studied the schools at first hand.

III. BASIS FOR ORGANIZATION OF SCIENCE IN THE HIGH SCHOOLS.

What should science do for high school pupils? This difficult question may be answered, in so far as we can answer it at all, partly from past experience in teaching science, and partly from more or less well-founded itself in what we think science *should* do for young people. It is well-

nigh impossible to make a statement of purpose based upon experience in teaching secondary school science. Experience is so varied, and so many pupils have had no science. But the testimony of those who have had such work, varied as it is, bears evidence that there has been given an insight into the nature of physical phenomena through courses in physics and chemistry; of life phenomena, life responses and of interrelations of plants, animals and men, through biological studies; of man's relation to the earth on which he lives through physiography; and of the uses of science through the above subjects and through domestic science and agriculture.

By combining our experiences with our beliefs, and possibly our hopes, we may state the things which science should do for high school pupils as follows:

1. High school science should give pupils such a knowledge of the world of nature as will help them to get along better in the course of everyday life.

2. Science can not help people in fundamental ways in everyday life without serving to make better people. The truths of science are the truths of life, and while one may for a time divert the verities of nature, the fundamental laws of science eventually correct these errors. While science, therefore, should enable people to get along better, it does so by improving the people through their improved attitude and intelligence in their work, and this means increased efficiency.

3. Science should stimulate pupils to more direct and purposeful activity and also should help them to choose intelligently for future studies or occupations. This purpose is common between science and other subjects of the curriculum, but can not be omitted from science because of the very large number of ways in which science is used in the world of affairs.

4. Science should give pupils methods of obtaining accurate knowledge, which method should assist in solving the pupil's own problems. It should develop an abiding belief in the value of accurate knowledge and the danger of dependence upon any other kind of knowledge.

5. Science, by giving pupils a greater and clearer knowledge of nature, should give them greater, clearer and more intelligent enjoyment of life.

IV. The Course.

(1) *First Year.*

(a) The first year science of the high school should be organized upon a broad basis involving fundamental principles of the various sciences and using materials from all, if needed. Certain large topics should be selected for study. These should have coherence in themselves; they should be so chosen as to allow of the scientific interpretation of the more common experiences of the pupils, and to lead to new experiences with common phenomena. Use should be made of materials from any of the sciences as may be needed for the study of the topics selected. Such a use of topics upon which various sciences are focused will introduce the pupils to the differentiated subjects.

(b) The important subject of physiology and hygiene should be combined with physical education thus making a complete course of instruction on the human body. This gives a scientific basis for physical education, and at the same time furnishes concrete applications of the principles of physiology and hygiene. In the few schools where the work has been organized in this way splendid results are being achieved.

(2) *Second Year.*

The second year science should also be organized upon a basis involving, to a considerable degree, fundamental principles of various sciences.

Emphasis should be placed upon the biological sciences and their applications. The life sciences and their physical basis are fundamental to a scientific understanding of the world's food, clothing, shelter and commerce; they give a knowledge of the significance of life upon the earth, and of the relationships of living things; they furnish a basis for personal and public hygiene, for the study of domestic science, of agriculture and of other vocational studies. In this year's work it is proposed to conserve the vital and fundamental parts of botany and zoölogy and to relate these definitely to their environment or physical basis of control. This will involve the continuous interweaving and unifying of biological science with commercial and physical geography. The application of many principles of physics and chemistry will be made. Knowledge and methods of work acquired in the first year will be utilized. The work of the second year will thus reach backward to the fundamentals of the first year, and will look forward to the more differentiated sciences of the third and fourth years.

(3). In the third and fourth years of the high school there are recommended different radiating lines of science studies to meet the diverging interests of high school students. These lines are physical and chemical science; domestic science; agricultural science; elective sciences. While any one pupil would take but one of these lines in its entirety, a small amount of election in other lines should be allowed. The first and second years' work should be required of all high school pupils. These first two years should furnish the proper basis for a continuation of the radiating lines of work. In domestic science and agricultural science, some physics and chemistry should be included, but should be taught from the point of view of their application to the particular field of study. In the physical science series, the subjects should be taught in a more comprehensive way, perhaps from the point of view of so-called engineering science. In the elective series, commercial geography, physiography, and other sciences which have not been taken may be included.

The above plan will necessarily eliminate some sciences from those available to some high school students, but it offers a definite scheme for science teaching and furnishes a plan upon which experiments with the curriculum may be carried out. By use of such a plan we may soon discover what sciences are least important in the high school and may thereby effect further unification of the course. It must be kept clearly in mind that the important thing is not to have each science represented in the high school course, but to include those phases of science which give the best education and open the widest opportunity to high school students. It is to be hoped that the discussion of the plan as presented will be from the point of view of those genuinely interested in effecting a better organization of high school science. Naturally this is difficult since we are so specialized in our interests that we are in danger of focusing our attention upon the effect which such a plan would have upon our particular science, rather than upon the efficiency of science in high school education.

Otis W. Caldwell, *Chairman*, Chicago, Ill.
James H. Smith, Chicago, Ill.
C. E. Spicer, Joliet, Ill.
A. W. Evans, Chicago, Ill.
W. M. Butler, St. Louis, Mo.

LIVE CHEMISTRY.

The recent Des Moines meeting of the Chemistry Section was most inspiring and enthusiastic. Teachers from various parts of the Northwest were present, and declared their belief in the value of the applied chemistry. They emphasized the study of chemistry as it is in operation in the activities of daily life rather than that formulated in books. The book should occupy a subordinate place in the study of real, vital, chemistry. Vocational chemistry was defined as the chemistry of different vocations rather than the study of chemistry as a vocation in itself. H. R. Smith, Lake View High School, Chicago, was appointed to continue to direct the applied work, and was given power to select assistants as might seem best to further the development of this field. Experiments will be published every month in SCHOOL SCIENCE AND MATHEMATICS for the benefit of Association members. The director urges all chemistry teachers having successful experiments of the applied nature, to send them in for publication. Observe all requirements of SCHOOL SCIENCE AND MATHEMATICS regarding form of manuscript. If the work can be improved by anyone's criticism the director will welcome such criticism. Any other kind is best unsaid. As a sample of the kind of experiments wanted the following one is offered.

PERCENTAGE OF AMMONIA IN COMMERCIAL AMMONIA WATER.

Every student of the class is required to bring from home or purchase a sample of domestic ammonia for analysis. Each student is made to understand that he is to make a real chemical analysis. The experiment just finished is one of neutralization in which it has been found that a standard acid solution requires the same volume of a standard base solution to reach the end point of the reaction. With the customary use of burettes each student finds the exact volume of standard hydrochloric acid needed to neutralize the ammonium hydroxide in 10 c.cm of the sample of ammonia. This volume of acid divided by ten tells what fraction or multiple of standard the sample is. A standard ammonia solution has 1.67 per cent NH_3. By multiplying, the desired per cent of the sample is found with no difficult calculation. The data of the whole class is tabulated on a chart or board with the brand, manufacturer, retailer, cost per liter, value per liter, name of analyst, and any remarks about time between first opening of bottle and analysis. The results range from 0.5 per cent to 4 per cent and have about the same retail price. The students are told to take the data of the best brands as well as those of poorest grade and have a talk with their grocers so that they may know the best brand to retail. The students readily comprehend that the grocers will be careful to furnish them with the best grade of goods if they have the ability to test and discriminate quality of goods. Besides learning how to determine the concentration of a solution, students learn other valuable lessons. The real object is to *know the truth regarding the content of ammonia.* The desire for this truth impels each student to duplicate the work until consistent results are obtained. The spirit of this work is vastly different from that shown when students are told to determine the concentration of a solution made up for them to practice on. They have no *real* interest in its concentration. It is only a task, artificial and nearly valueless. Why need we perform such experiments, even if they are written in books? There are plenty of inspiring experiments to be found in the real activities of men for them to practice on. Let us have experiments in *real* chemistry in place of every artificial one now written in the laboratory manuals.

H. R. SMITH.

EXPERIMENT IN DYEING.

OBJECT: To illustrate the process of indirect dyeing—a process of dyeing by the use of a mordant acting on a dye and forming a lake.

SUPPLIES: Potassium dichromate; a soluble lead salt; a soluble silver salt; four squares of cotton cloth.

PROCEDURE: 1. Dissolve a little potassium dichromate in a little water in an evaporating dish. Put into this two pieces of cotton cloth. After a few minutes, remove a piece. Press or wring it as dry as possible and then hang it up to dry completely. We will use this piece for comparison as to color. Record.

2. Remove the second piece of cloth and wash it under the tap. Dry it. Compare its color with that of the piece in 1. Describe. Is the color fixed?

3. Put a third piece of cloth into a weak solution of a lead salt prepared in another evaporating dish. Press or wring the cloth as dry as possible, after it has been thoroughly soaked in the lead solution. Now dip the cloth into the potassium dichromate solution. Take out the cloth and wash it under the tap. Is the color permanent? Dry the cloth. Describe.

4. Use a *clean* evaporating dish make up a little dilute solution of silver nitrate. Dip the fourth piece of cotton into this, seeeing that it is thoroughly wet by the solution. Press or wring out the cloth. Now, dip the cloth into the potassium dichromate solution. Wash it under the tap. Is the color permanent? Dry the cloth. Describe.

EXPLANATION: 1. Name the mordant use in each of the four cases.

2. Name the dye used in each of the four cases. Is it soluble or insoluble?

3. State the color of the lake formed in each case. Is it soluble?

4. State the relation between the permanence of the color and the solubility of the coloring matter deposited on the fibres of the cloth.

(After student has prepared copper nitrate solution, evaporated it to dryness and heated it till no further change occurs, have him repeat using solution of silver nitrate, then):

a. Take half-a-dime (cut the coin in two with tinner's snips), weigh it and treat it with the proper acid. While action proceeds to completion write equations, compute amount of metal and calculate the weight of each salt formed. When metal has disappeared add water, if necessary, to make 60 cc.

b. Put one-third of the mixed solutions into an evaporating dish and evaporate carefully to dryness (no spattering!). Heat, noting color changes, till entire content of dish is black and shining. Give equations to account for color changes. Cool, add 50 cc. of water, dissolve as far as possible, filter and save filtrate as reagent silver nitrate.

c. While evaporating (b), add hydrochloric acid in slight excess to remainder of solution (a) shaking well; decant and wash precipitate free from adhering copper salt, testing wash-water with potassium of ferrocyanid solution to make sure that no copper remains. Make two portions of the precipitate. Equations.

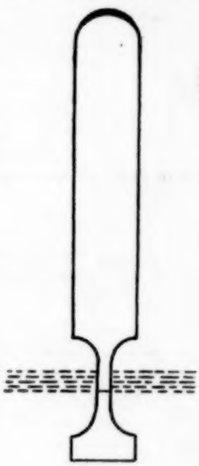
d. To one portion add solid sodium carbonate and heat on charcoal with oxidizing flame of blowpipe till bright metal bead is obtained. Equations. Save bead.

e. Treat third portion with zinc and dilute sulphuric acid, stirring to break up all lumps of the precipitate. When solid is uniformly grey with no traces of the white silver chlorid, remove remaining zinc and wash repeatedly as in (c). Equations. Put grey mass with bead from (d)

and fuse two together and weigh. Compare all calculations with those obtained by others. Finally fuse the metal obtained to the head of a long pin and wear it as a "Chemistry Stick-pin." C. M. Wirick.

A CONSTANT IMMERSION HYDROMETER.

One hundred small steel balls of uniform weight (cycle bearings) are weighed. A piece of glass tubing of about 15 mm. diameter is closed at one end in the blowpipe flame, and the closed end slightly thickened. Its weight is then found, and a piece of it weighing about a gram less than 100 balls is cut off. This is counterpoised against the balls, small leaden shot being put into the tube to equalize the weights. The end of the tube is then heated until the shot are fused to the glass. The tube is next drawn out into the shape shown in the figure, and the level at which it floats in water is marked on the neck. If the tube is put into a liquid of specific gravity 1.21, it will sink to the mark when 21 balls are dropped in. The fused lead breaks the fall. Thus, the number of balls required indicates the specific gravity of the liquid, and the relation between the upthrusts of equal volumes of liquids of different densities is made clear. For liquids lighter than water, a tube equal in weight to 50 balls, which just floats in water with a load of 50 balls, can be used.—*School World.*



SCHOOLHOUSES BY PARCEL POST.

Sending cardboard models of schoolhouses by parcel post is the latest device of the United States Bureau of Education for arousing interest in attractive school buildings at low cost for rural communities. The models are made to hold flat and are shipped by mail to local authorities, normal schools, and other agencies, for use during a limited period. A number have already been sent to points in the West and Southwest.

Models for one, two, and four-room schools are provided. The buildings are planned especially for rural communities where low cost is the first essential. They represent the very latest ideas in school architecture; they are usually attractive to look at; they are up to the minute in hygienic arrangements; yet they are within the means of the smallest communities.

The buildings were designed by Dr. F. B. Dresslar, specialist in school hygiene of the Bureau of Education, and then worked over by two well-known firms of school architects, Cooper & Bailey, of Boston, and W. B. Ittner, of St. Louis. The models show all the details, within and without, and they are constructed to scale. Full directions accompany them.

It is believed that these models will be of great assistance to school authorities in small rural communities who can not afford to engage a school architect, yet are ambitious to have their schoolhouse up-to-date in every particular. With one of these models to work from, Dr. Dresslar asserts, any carpenter will be able to build a schoolhouse for his district that will meet every modern requirement.

THIRTEENTH ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The thirteenth meeting of the Central Association of Science and Mathematics Teachers was held in East High School, Des Moines, Iowa, Nov. 28 and 29, 1913. Although held farther west than the meetings of the Association have ever been located before, the attendance and interest were gratifying. The facilities offered by the building in which all meetings were held and the completeness of the local arrangements contributed very much to a successful meeting.

The General Sessions were held in the auditorium of the high school and were presided over by President Millis. At the Friday morning session the address of welcome was delivered by Superintendent Thornburg of Des Moines. The response on behalf of the Association was by Dr. E. R. Hedrick of the University of Missouri. The two principal addresses of the session were by Dr. Florian Cajori and Dr. O. W. Caldwell. Dr. Cajori's subject was "Science and Mathematics in Vocational Schools; a Retrospect," and Dr. Caldwell spoke upon "Science and the Changing Ideals of Education." At the conclusion of these addresses a preliminary report was presented by the Committee on a Four-Year High School Science Course. This report is printed elsewhere in the Proceedings. The report was received and the committee continued. Members of the committee are O. W. Caldwell, chairman, James H. Smith, C. E. Spicer, W. M. Butler, A. W. Evans, and Geo. D. Works.

Friday afternoon was devoted to the section meetings and to a reception held in the corridors of the building. At the annual dinner in the evening there were short speeches by Messrs. Wade, Peet, Newhall, Eikenberry, and C. H. Smith, representing the several sections, Mr. James H. Smith acting as toastmaster. The unity of interests of the sections was emphasized. After dinner the Association adjourned to the auditorium and were addressed by Dr Rollin D Salsbury of the University of Chicago, on the subject "In and About Patagonia."

The General Session of Saturday morning was devoted to business. The Secretary reported the results of the postal card vote on change of date of meeting as follows:

In favor of change of date........................29
Opposed to change of date........................209

There was therefore a large majority in favor of retaining the present time of meeting. It was moved and carried that there be no change in date.

The Auditing Committee reported that they had found the Treasurer's accounts to be correct, whereupon the report of the Treasurer was read and adopted. The Treasurer also read a membership report showing a net gain of 60 members. These reports will be found separately printed in the Proceedings.

The Nominating Committee reported the following:

President, Willis E. Tower, Chicago.
Vice President, E. Marie Gugle, Toledo, Ohio.
Assistant Secretary, Jessie F. Chaplin, Minneapolis, Minn.
Treasurer, H. R. Smith, Chicago.
Assistant Treasurer, Lewis B. Mull, Ottumwa, Iowa.

The Secretary was ordered to cast the ballot of the meeting for the persons nominated and they were duly declared elected.

The President reported from the Executive Committee a suggestion

that sections be organized in Agriculture, Domestic Science, and Manual Training. It was decided that action be taken to establish sections for Agriculture and Domestic Science. No action was taken regarding Manual Training. The President-elect was empowered to appoint a committee of three for each of the new sections, these committees to proceed with the organization of the sections and provide programs for next year.

It was also decided that hereafter the Committee on Resolutions should be appointed a year in advance in order that time might be available to prepare a more adequate statement of the principles of the Association.

The Secretary read the following report from Professor C. R. Mann, delegate of the Association to the Council of the American Federation:

To the Central Association of Science and Mathematics Teachers.

Gentlemen: Your delegate to the Council of the American Federation attended the meeting of the Council in Cleveland last December. Reports there presented showed that the Federation's geometry syllabus had been reprinted in the *Mathematics Teacher,* and another 5000 reprints ordered for distribution. The sum of $70 was appropriated to pay for this. The work of the Committee on Practical Apparatus in Physics has been progressing, and $50 was appropriated to continue this. The Treasurer reported a balance of about $110 in the treasury after paying these appropriations.

The future work of the Federation was discussed at length, and it was decided that it is not just to ask men to undertake the kind of work the Federation is organized for on the small income that accrues from the 10 cents per capita dues (about $200 per year). It was therefore voted to appoint a committee to see whether other means of financing the work might not be discovered, and in the meantime to undertake no new work and to ask for no dues from the local organizations for the year 1913. Another meeting of the Council will probably be held next month, and if no more adequate means of financing the work have been discovered, the organization may be discontinued. Under these conditions, your delegate suggests that this Association take no action now with regard to the Federation, but leave matters as they are until the Federation Council makes further report. Report accepted.

Dr. Florian Cajori and Dr. Rollin D. Salisbury were elected to honorary membership in the Association.

Mr. James H. Smith reported for the Committee on Four-Year Course in Science that of the $75.00 allowed for the expenses of the committee but $2.50 had been used, and requested that an allowance of $50.00 be made for next year's expenses. Request granted.

Urgent invitations were extended to the Association to hold its next meeting at Toledo, Ohio, and at Gary, Ind. It was the sense of the meeting that the next meeting should be held at Chicago and with this understanding power to fix upon location was delegated to the President, Secretary and Treasurer.

Upon motion of Mr. C. H. Smith the following resolution was adopted:

"Resolved, That the Central Association of Science and Mathematics Teachers, in annual meeting assembled, at Des Moines, Iowa, do unhesitatingly, in the strongest terms, condemn the use of soapstone or other mineral material as a substitute for wood on physics or biology laboratory and lecture room table tops. The soapstone is too soft, easily becomes scratched, thus rendering it unfit to be used as a writing desk; it is more expensive than wood; uprights and framework cannot be easily fastened to it; it is easily broken and being a good conductor of heat always feels cold, especially in winter, to the touch.

"It is recommended that a top of hard wood be used, made up of nar-

row strips, glued together, and wide and long enough to project at least three inches over the rail on all sides."

The Committee on Resolutions reported the following resolutions which were adopted:

REPORT OF THE COMMITTEE ON RESOLUTIONS.

The Committee on Resolutions unanimously recommends the adoption of the following:

Whereas, The meeting just closing at Des Moines, Iowa, has been one of the most inspiring meetings ever held; therefore,

Resolved, That the Central Association of Science and Mathematics Teachers hereby expresses its cordial thanks to the Board of Education of Des Moines, Iowa, to the Local Committee on Arrangements, to the Committee on Publicity, and to the Committee on Membership, for their untiring efforts to provide every facility and comfort for the Association, and for their cordial hospitality, which has made the success of the meeting so great; that it expresses its appreciation of the action of the Iowa State Science Teachers Association and the Iowa State Mathematics Teachers Association in waiving their annual meetings the current year and in urging their members to attend the meeting of the Central Association; that it expresses its thanks to the Iowa teachers for their generous hospitality in providing the complimentary luncheon to visiting teachers.

Resolved, That this Association hereby accords a hearty vote of thanks to Professor Florian Cajori, to Professor Otis W. Caldwell, and to Professor Rollin D. Salisbury for their vital and invigorating addresses.

Resolved, That we express our appreciation of the work of the Des Moines newspapers in furthering the work of this Association by preliminary announcements of the meetings and by their excellent service in reporting the proceedings of the convention.

Resolved, That this Association hereby expresses its sincere appreciation of the faithfulness and untiring efforts of the President, Mr. James F. Millis; and of the former Secretary and present Treasurer, Mr. C. E. Spicer, through whose combined efforts this Association has increased greatly in membership and power.

Resolved, That this Association approves the organization of four-year courses in high school science, based fundamentally on a study of what young people need and can use, and believes that it is one of the chief problems before us to find out by experiment how such courses can be effectively created.

Resolved, That this Association recognizes the importance of the vocational trend that the teaching of science and mathematics is now taking, and urges the necessity of finding a method of organizing courses in science and in mathematics, which shall make these subjects of greater social and economic value to pupils without diminishing their high value as instruments of a truly democratic education.

Resolved, That this Association approves of the movement to economize time in education by reducing the time of the elementary school from eight to six years and increasing the period of secondary schooling from four to six years, believing that this administrative change will help this Association and other similar bodies in carrying on their work of strengthening the teaching of science and of mathematics.

Respectfully submitted,

C. R. MANN.
MARIE GUGLE.

Minutes of the meetings of the sections, as well as many of the papers presented, appear elsewhere in the Proceedings.

W. L. EIKENBERRY, *Secretary*.

MEMBERSHIP REPORT FOR THE YEAR ENDING NOV. 28, 1913.

Paid up membership, Nov. 27, 1912		559
Honorary membership, Nov. 27, 1912		7
Total membership, Nov. 27, 1912		566
Delinquent but left on list as per constitution		67
Total names on list, Nov. 27, 1912		633
New names added during year		146
		779
Resigned during the year	52	
Deceased, or dropped for delinquency	39	91
Total names on list, Nov. 28, 1913		688
Delinquent but left on list as per constitution	62	
Honorary membership. Nov. 28, 1913	7	69
Paid up membership, Nov. 28, 1913		619
Net increase of membership for the year		60

C. E. SPICER, *Treasurer.*

TREASURER'S REPORT FOR THE YEAR ENDING NOV. 28, 1913.

RECEIPTS.

Balance shown by last report	$ 233.90
Advertisements in 1912 program	269.00
Advertisements in 1913 program	132.00
Tickets for annual dinner at Evanston	50.00
Three copies of Correlation Report at 25¢	.75
Eight copies of Proceedings at 50¢	4.00
Dues of 448 members at $2.50	1,120.00
Dues of 67 members at $2.00	134.00
Dues of 23 members at $1.00	23.00
Dues of 46 members at 50¢	23.00
Total receipts	$1,989.65

EXPENDITURES.

Subscriptions to SCHOOL SCIENCE AND MATHEMATICS	$ 767.50
Annual dinner at Evanston	50.00
Printing and distributing 3,000 programs for 1912 meeting	291.94
Postage in office of Treasurer	41.00
Printing and distributing Historical Pamphlet	96.50
Badges for 1912 meeting	8.75
Expenses of Section Meetings, 1912	2.00
Reprints of Constitution and of Resolutions	3.25
Badges for 1913 meeting	10.00
Rebates to local centers for dues of members	4.50
Expenses of speaker for 1912 meeting	6.02
Expenses for janitor service at 1912 meeting	1.50
Premium on Treasurer's bond for $1000	2.50
Expenses of Membership Committee of 1912, postage and exp.	26.94
Expenses of Membership Committee of 1913, postage and exp.	20.51
Printing letter heads, circular letters, receipts, etc.	47.00
Mailing programs of 1913 meeting	5.01
Printing and distributing Proceedings for 1912	201.09

Postage and supplies for office of Secretary	8.47
Total expenditures	$1,594.48
Balance cash on hand	395.17
	$1,989.65

C. E. SPICER, *Treasurer.*

Minutes of the Biology Section.

The Biology Section was called to order by the chairman, Mr. J. G. Coulter, at 1:30 Friday afternoon, November 28th.

The general subject for discussion was "The Place of Plant and Animal Studies in a Science Program for Secondary Schools." The discussion followed the general lines indicated by the chairman in a brief summary of the specific points of the general topic upon which it seemed desirable to have an expression of opinion by the members of the section. These were as follows:

I. That a course in science should be required of all in the first two years of the high school course.

II. That, to be science in the educational sense, a course must be scientific both as to teaching method and as to the organization of subject matter. No course should be classed as science simply by virtue of the nature of the information imparted. (Certain courses call for special caution in this connection.)

III. A. That, preferably, the course indicated in I should have continuity through grades IX and X.

B. That, if the course can be given in one year only, grade X is preferable to grade IX.

C. That double periods are not essential for this course.

D. That human relation to environment should be the primary theme of this course.

E. That the study of organisms and of chemical and physical phenomena directly related to life should have at least three-fifths weight in such a course.

F. That in this course plant studies should precede animal studies, and that the teaching of alternating plant and animal types, and the organization of the biological subject matter primarily on the basis of general principles are not recommended for this course.

G. That the technical use of the term *food* should be restricted to organic substances.

IV. A. That in grades XI and XII various full year electives should be offered, and that such electives should presuppose the course indicated above.

B. That, when possible, differentiation should be made in these upper courses between those taken by students expecting to go to college and those taken by students not expecting to go to college.

C. That the "college" courses should be administratively equivalent to the similar courses given at colleges, and that college credit should be obtained therefore.

D. That the "non-college" courses of this group should have vocational character, agriculture and domestic science being characteristic thereof.

Mr. E. L. Mahaffey of the High School of Commerce, Columbus, Ohio, opened the discussion. He expressed himself as thoroughly in accord with the idea of making two years of science the minimum in all courses. In most courses science should find a place in all four years. As to the

place and content of such courses neither has been worked out satisfactorily as yet, probably owing to the fact that the schools have attempted to deal with too many subjects. The number should be reduced. Biology, chemistry, physics, geography and agriculture would perhaps cover everything that should be attempted. Geography should be an intensive fourth year rather than a mediocre first year introduction to science. Physics should find a place in the third year, while chemistry may be adapted to second year work, or agriculture may be placed in the second year to splendid advantage. Biology should come in the first year for two reasons. First, because it is a subject which beyond question has the greatest influence upon the later lives of boys and girls. For this reason it should be placed first in the course in order to reach the greatest possible number Second, because biology is concrete rather than abstract. It deals with material things, which can be seen, touched, and felt. It is this capability of being demonstrated which makes biology the logical beginning science. As to the content of the course, general biological factors should be presented first. The double laboratory period is to be preferred.

The second speaker, Mr. H. B. Shinn of Carl Schurz High School, Chicago, thought that one serious defect in the organization of courses in science is that such courses are not adapted to the pupils. The growing belief that the break in school work is not between the eighth and the ninth grades, but between the seventh and eighth grades seems to indicate the advisability of a readjustment of work in those grades, placing a part of the work of the eighth grade in the seventh and adapting the work of the ninth grade to the eighth. This with departmental teaching would make possible a more unified course of study. In science this would consist of two years of general science in the eighth and ninth grades, followed by three years of further work which should be elective and which should have more work of a practical nature. This general course would be elementary in character laying the foundation for later work which might be collegiate, industrial, or agricultural according to local conditions. The teacher should incorporate into this course related material, both to counteract the tendency to specialization, and to give pupils an idea of the interrelation of the sciences.

As to the content of the course the natural sciences tend strongly to lead the mind away from itself into broader fields, while the physical sciences tend to make the mind egoistic and self centered.

Whether the high school should offer collegiate and college preparatory must depend upon strong local demand. If such courses are offered they should be directed by the state university. This is a secondary matter. The main business of the high school is to educate that 90 per cent that never go to college. Its business is to serve the needs of its community, not to be a feeder for the college.

Dr. Bailey of Cedar Rapids believed that one serious obstacle to be overcome is the prejudice still existing in secondary schools in favor of classic subjects, especially in the smaller high schools—a feeling that stands in the way of giving the full four years to science that the importance of the subject warrants and which is accorded without question to other subjects. The educational value of science teaching must depend upon the personality of the teacher. Considerable discussion was evoked over the desirability of standardizing courses in science as a means of avoiding needless repetition on the part of the students in later college work.

Mr. Douglass of North Des Moines High School maintained that the content of the course was not significant—the important point was that it should be vital. The test of the value of the course was whether it gave

the pupil knowledge of himself, whether it stimulated interest in his surroundings, putting him in harmony with his environment. The speaker advocated nature study in the grades as a means of keeping alive that spirit of inquiry inherent in the young child, and which is too often lost in later school life.

Mr. Garber of Yeatman High School, St. Louis, spoke on the desirability of plant studies preceding animal studies in high school science, urging as a reason that plants come more prominently into the pupil's environment, and are easily obtained. Furthermore, plants are more suitable for experimental work, the study of the growth of cells, repair of cells, reproduction, and the response to environment. The basis for instruction in sex hygiene may well be laid in the study of plants. The pupil arrives at a better understanding of the life processes of his own body through the study of the processes which are fundamental to the life activity of all organisms, as shown in nutrition, digestion, absorption, and the transfer of liquids in plants, growth and repair of living tissue.

As to the place of the study in the course, in the opinion of the speaker, the tendency toward placing the biological studies in the later years of the high school course, is due to the spirit of specialization which is finding its way down to the high school from the college and university through teachers untrained in methods of reducing the subject matter to the level of comprehension of the average high school pupil. The colleges are not giving us teachers who are alive to the needs of the high school in this work. There is nothing in any high school science which should demand the mature development of the senior. Proper presentation of material is the significant thing.

Mr. Ewers of the McKinley High School, St. Louis, raised the question as to whether there was an actual decrease in the number of pupils taking science in the past seven years as statistics given seemed to indicate. If so, to what could this be ascribed? It was brought out in the discussion that the statistics upon which such conclusions were based were misleading, inasmuch as they included pupils of a single year or at most two years of science, as compared with the total number taking English or mathematics in the three or four year course. Mr. Ewers suggested some valuable lines of work in botany that could be carried on to advantage in city schools. Tree study and garden work should be in any such course. Experimental work in the plant laboratory and school greenhouse should be especially emphasized as it serves to vitalize the work. A two years' science course is desirable in the early years of the course.

Miss Charlotte H. Stetson of Princeton Township High School believed that two years of science should be required of all pupils in the first two years of the high school, both on account of its practical value and because of the training it afforded in logical thinking. A single year of any science is not enough.

The Saturday morning session was devoted to the further discussion of the specific points brought out by the speakers of the previous session. The following resolutions were adopted by the section after considerable discussion of the points involved:

First, That a course in science should be required of all in the first and second years of the high school as at present organized.

Second, That this course should be synthetic of material drawn from the various branches of science—and should have unity in its organization as a whole.

Regarding the content of such a course, considerable discussion was evoked. Mr. Eikenberry believed that the order of presentation of material in the course should be left to the judgment of the teacher, who should not be limited to a certain line of work.

Third, That we recognize the desirability of teaching elementary science or nature study in the grammar grades, and urge that such work be made a part of the course in those grades.

Miss Peterson of Sioux City High School thought that it might be inadvisable to urge the question at this time owing to the already crowded condition of the average school program, and to the fact that few teachers were prepared to handle the subject.

Miss Merrit of Ottumwa thought this last difficulty might not be a serious hindrance as the work could be placed under the supervision of the high school science teacher.

Fourth, That the size of science classes be limited to twenty-four pupils.

Fifth, We urge at institutions concerned the establishment of a course designed specifically for the preparation of high school teachers of general science, believing that equality of attention to various branches of science, is requisite in this connection, and that overspecialization is undesirable for this purpose.

The report of the Committee on Nominations was made and the following officers were elected for the ensuing year:

Chairman, H. B. Shinn, Carl Schurz High School, Chicago.

Vice Chairman, A. F. Ewers, McKinley High School, St. Louis, Mo.

Secretary, Miss Charlotte Stetson, Princeton High School.

ETTA M. BARDWELL, *Secretary.*

Minutes of Chemistry Section.

The Chemistry Section held two meeetings in East High School, Des Moines, November 28th and 29th.

FRIDAY AFTERNOON MEETING: The meeting was called to order by Chairman W. F. Roecker, Madison, Wis. In the absence of Secretary E. F. Downey, C. W. Botkin, Ottumwa, Iowa, was chosen temporary Secretary. Mr. V. C. Lohr of Joliet, Ill., was unable to be present to give his paper on "Relation of Theoretical to Applied Chemistry."

"Practical and Correlated Chemistry for Grades and High Schools" was presented in a paper by S. G. Engle, Gary, Ind.

"The Limitations in Making a Course in Chemistry Practical" were given in a paper by F. B. Wade, Indianapolis, Ind.

A discussion of the above subjects was led by Miss Sara Nollen, Des Moines, Iowa, and participated in by most of the members present. Some of the points emphasized in the discussion are as follows: Vocational chemistry is for the few who become chemists, and its teaching is largely the work of the college. High school chemistry must be taught for its application in the usual vocations. It should be based on the necessary principles and theories of chemistry, but with a large application to sanitation, domestic science and community affairs. Some experiments along these lines were described and results discussed. Segregated classes were advised, especially in the latter part of the course, where the work of the girls would be of a household nature.

The chairman appointed the following committees:

Nominations—F. B. Wade, Miss Jessie F. Caplin, Minneapolis, Minn., and Mr. H. A. Senter.

Resolutions—H. R. Smith, Highland Park, Ill., S. G. Engle, and Miss Frances Church, Des Moines.

The section held a joint session with the Physics Section. Papers were read by Prof. G. W. Stewart of the University of Iowa, on the "Teacher's Conception of Physics," and by Prof. C. R. Mann, of the University of Chicago, on "What Is Vocational Physics?"

SATURDAY FORENOON MEETING: Vice Chairman Sara Nollen presided. Prof. R. E. Smith, Ames, Iowa, read a paper on "Some Experiments Dealing with Practical Affairs of Daily Life."

The report of the Committee on Practical Experiments in Chemistry was read by Mr. H. R. Smith.

Chairman Roecker led in a discussion of the above papers. Some new experiments were suggested and ways of making chemistry interesting and more useful were discussed.

The report of the Committee on Experiments was accepted and the work of the committee continued under the direction of Mr. H. R. Smith.

The report of the Committee on Nominations was read and received the entire ballot of the section. The officers chosen for the next meeting were:

Chairman, H. M. Ibison, Marion, Ind.
Vice Chairman, Isabel Henkel, Milwaukee.
Secretary, H. D. Abells, Morgan Park, Ill.

Total attendance, 24.

C. W. BOTKIN, *Secretary pro tem.*

Minutes of Earth Science Section.

The meeting was called to order by Miss Zania Baber, the chairman of the section. In the absence of the regularly elected Secretary, Mr. Peet was appointed. The program had to do with the vocational aspect of the earth sciences. Professor R. D. Salisbury spoke of the "Vocational Aspect of Geology." Professor A. C. Trowbridge of the University of Iowa and Miss Bertha Henderson of the University of Chicago High School spoke of the "Vocational Aspect of Physiography." A paper on the "Vocational Aspect of Commercial Geography" was read by Miss Alison E. Aitchison, Iowa State Teachers' College, and a paper prepared by President W. J. Sutherland of the State Normal School, Platteville, Wisconsin, on the "Vocational Aspect of Regional Geography" was read by Professor Sanford of the same institution. The two papers last mentioned will be published in full in SCHOOL SCIENCE. A synopsis of the paper by Professor Salisbury prepared by himself appears elsewhere in this number.

In the discussion of the "Vocational Aspect of Physiography," which was divided between Miss Bertha Henderson and Professor A. C. Trowbridge, Miss Henderson said that the aim of physiography is no longer solely to train the mind of the student into a scientific attitude but to show the relation between earth science and the things in the student's environment both immediate and also more remote, to give a glimpse of some of the great enterprises and great problems of the present day upon which physiography has a bearing. She called attention to the fact that physiography touches upon the fields of work of the civil engineer, the forester, the agriculturist, the mining engineer, the navigator and of many others. It brings the student into contact with problems of conservation, transportation, water supply, protection against destructive action of the elements and control of their constructive action. It calls his attention to many vocations, the existence of which would otherwise be wholly unknown to him and unconsidered in his choice of a life work. In closing she said: "The great problem in education today is vocational training. It is wiser to retain our already organized subjects and to adapt them to the needs of the boys and girls than it is to throw away all the old material and start in untried lines with chaotic untried material."

Professor Trowbridge called attention to the importance of physiography for the professional geologist in his great task of interpreting the history of the earth, making it possible to supply chapters in this history which

are wholly lacking in the accessible parts of the rock record. As examples of its importance to the economic geologist placer deposits and the recovery of gold from them through physiographic processes were mentioned. The removal of the Maquoketa shales of Wisconsin and Iowa made possible the lead and zinc deposits of the underlying dolomites. The close relation of physiography to geography and to history and economics was mentioned. Without physiography, there can be no intelligent teaching of geography. The conditions which control agriculture are most fundamental in economics. Soil, rainfall and climate are physiographic subjects and are controlling factors in agriculture. The influence on the philosophy of the high school student when he comes to realize the great results produced by the slow processes of nature acting through a long time is worth while. Although human nature changes slowly, in time great changes may come. That physiography knowledge has a bearing on medicine was shown. Diseases are conveyed by water and by air. Temperature conditions, air pressure, the purity of the air and of the water supply, all have their influence on the production of or the cure of disease. Even in law physiographic questions may be involved. Boundaries are changed by streams, the ground water level is changed by draining mines, thus causing wells to run dry, a farmer's land is washed away while his neighbor's land is increased. In numerous other legal situations, physiographic questions are involved.

In the discussion which followed these papers, Professor Tilton of Simpson College, Professor Pammel of the Ames Agricultural College, Professor Kay of Iowa State University, Professor Sanford of Platteville, Wisconsin, Professor Salisbury of the University of Chicago, Professor James H. Smith of Austin High School, Chicago, Professor Spicer of the Joliet Township High School and others, took part. Mention was made of the report of the Committee on a unified science course for the High School and of its probable effect on the work in physiography now generally in the first year of the high school. Professor Sanford spoke unfavorably of the work that is being done in Wisconsin in the so-called "General Science" courses. Professor Spicer called them "chop-feed" courses and said that he believed the revolt against physiography was due to the introduction of the college course in the subject into the first year of the high school instead of a course adapted to students of high school age. Professor Smith suggested that the agitation some years ago for more emphasis on the human element was the beginning of the revolt. He said that the leaders in high school physiography were making progress and that if there had been less haste and less impatience, the physiography courses would have developed satisfactorily. Professor Salisbury said that to get teachers prepared in physiography is difficult. To get them prepared in several subjects would be more difficult.

In the continuation of the discussion Saturday morning, Mr. Peet said that his experience had led him to feel sure that if physiography were broadened out to reach down into the underlying physical sciences and up into the study of life it might very well be made the central subject in the proposed two year introductory science course. For the sake of improving the work in the physiography itself he had found this a desirable thing to do, because, for one reason, it made it possible to introduce the experimental method to a larger extent than could be done within the strict limits of the orthodox course in physiography. To produce better results in our high school science we do not need ***uniform*** courses, but UNIFIED courses. It is not necessary and it is not desirable that the work should be everywhere alike. He ended with making a plea for an open-minded attitude toward the work of the committee and the use of the

boasted scientific methods in the solution of this important problem. We owe allegiance to no subject. Our responsibility is only to the young people in our charge.

Professor Kay announced that the University of Iowa has engaged a man whose duty it is to give instruction in how to teach physical geography. He also announced that Professor Trowbridge has prepared eight sets of lantern slides with accompanying descriptions which are available for use by the physiography teachers in the high schools of the state.

On Saturday morning owing to the inclement weather, the field excursion was abandoned. Professor Kay gave an interesting and instructive lecture on the "Glacial Epoch in Iowa," illustrated by lantern slides.

A committee was appointed to investigate the present status of the high school physiography as follows: C. E. Peet, chairman, Miss Aitchison, Miss Smedley, Professor Sanford.

A committee on illustrative material was appointed: Miss Baber, chairman, Mr. Harry Clem and Mr. James H. Smith.

The following officers were elected:

Chairman, Professor Kay.

Vice Chairman, Miss Aitchison, Iowa State Teachers College.

Secretary, Miss Grace Baird, Bowen High School, Chicago.

CHARLES EMERSON PEET, *Secretary pro tem.*

Minutes of Physics Section.

FRIDAY AFTERNOON SESSION: Chairman C. F. Adams called the meeting to order promptly at 1:30 P. M., attendance about 40. In the absence of the Secretary, the chairman appointed C. H. Slater Secretary pro tem. The following Nominating Committee was then named: Mr. W. E. Tower, Chicago; Miss Emma J. Fordyce, Cedar Rapids, Iowa, and Mr. C. H. Slater, St. Louis, Mo. After a short discussion as to the general interests of the section, a motion was carried that the Chairman, Vice Chairman and Secretary be constituted an Executive Committee to direct the activities of the section.

The first paper of the section, "What Girls Can Do, and Should Do in Physics," by Miss Emma J. Fordyce, Cedar Rapids, Iowa, was a most interesting and practical presentation of the subject. The girls and boys in the Cedar Rapids High School have been taught in separate classes for some time, hence the points in the paper were given by one with whom this work is no longer an experiment, but successful experience. In that school the girls have shown greater interest and freedom of discussion in separate classes. The topics covered are almost entirely those of special significance to girls, e. g. the following: Machines—sewing, washing, cleaning; water, gas and electric meters; water pressure and systems; heating, ventilation and lighting; refrigeration; plumbing; sounds, musical instruments; electric bells, irons, lamp, motor, etc., etc. More and more has the work of the home been lightened by application of mechanical and physical principles, and never before has it been so important that a girl should have an adequate knowledge of elementary physics. It must be practical, significant and not theoretical. The paper was freely discussed and its ideas approved. Several teachers were present from schools where segregated classes are being tried out. They stated, in brief, as follows:

Mr. Tower, Englewood: Physics problems are *real* problems for girls.

Mr. Adams, Detroit Central: Segregated classes prevail throughout the school.

Mr. Glynn, Gary: Boys and girls prefer separation and do better work under different methods.

Mr. McClellan, Gary: Discussion in segregated classes leads in different directions.

Mr. Burrows, Des Moines: Girls' classes progress faster, and have more interest.

Mr. Barber, Bloomington: Omit much of the theory and give home applications; go from environment to principle.

Miss Cora G. Hathorn, Mason City: It is easier to adapt the work to the needs of the pupils.

The second paper was by Prof. L. P. Seig, University of Iowa, on "The Energy-Quanta Theory of Light." It was a very clear exposition of this newer theory of light. Prof. Seig said that it should not be taught, but that the wave theory be given as *a* theory, not as *the* theory.

At this point in the program the Chemistry and Physics Sections met in joint session to hear an address of interest to both by Prof. G. A. Stewart of the University of Iowa, subject: "The Teacher's Conception of Physics." The following excerpts show us as teachers that the child, and his needs, not the subject, is the important thing ever to keep in mind:

1. Physical research is never more *accurate* than is necessary. *Accuracy* should not cloud the *appreciation* of the subject.
2. Classification should be reduced to a minimum; it has its value but should not lessen the *appreciation*.
3. The attitude of mind is important; progress can only be made with an open, receptive mind.
4. Fundamental truths and principles, as *ends*, are not interesting; they give perspective vision when found in the many activities of life.
5. The attitude toward applied physics and chemistry should be to satisfy the *needs* of the pupil.
6. Mathematical formulae, etc.; physics exists aside from mathematics; do not use it if it does not help in something. Physics is a "Human document."

"What is Industrial Physics," by Prof. C. R. Mann, University of Chicago, concluded the program of the afternoon. If anyone expected another physics syllabus, he was disappointed. Instead Prof. Mann presented the thing that syllabi cannot give, the most valued product of all, the real "Scientific Spirit." Sciences have aided industry and elsewhere in many ways, theoretically and practically. Geat industrial progress has come about through this spirit. It has been revealed to the world in the lives of such men as Maxwell, Faraday, Watt, the Wrights and others. It is the instinctive inner faith to strive, to will to do, and to appreciate the thing done. It is a faith in the harmony of things, in achievement, in men. This is the spirit that the public believes in and demands today. Syllabi of facts are no longer the great thing. Part time school and shop seems to give the spirit. Any subject matter that secures the absorbing interest of pupils gives it. Achievement give it. The physics that develops this spirit is industrial physics. This spirit is what industry wants.

Saturday Morning Session: The report of the Nominating Committee was first called for, and was given as follows: Chairman, F. E. Goodell, Des Moines, Iowa, Vice Chairman, Mr. C. M. Brunson, Toledo, Ohio, and Secretary, Mr. Earl R. Glenn, Gary, Ind. Upon motion, the Secretary cast the ballot of the section for these officers for the ensuing year. The following resolution as to stone top tables was then offered and unanimously passed:

Resolved, That the Physics Section of the Association of Science and Mathematics Teachers in annual meeting assembled at Des Moines, Iowa, do unhesitatingly, in the strongest terms, condemn the use of soapstone or other mineral material as a substitute for wood as physics or biology laboratory and lecture room table tops. The soapstone is too soft, easily becomes scratched, thus preventing pupils using it as a writing desk, it is

more expensive than wood, uprights and frame work cannot be as easily fastened to it, it is easily broken, it being a good conductor of heat always feels cold, especially in winter, to the touch.

We do recommend a wood top made up of narrow strips glued together, wide enough to project over the rail at least three inches on all sides.

The chief paper of the morning was then given by Mr. Walter R. Ahrens, entitled, "Two Year Vocational Course in Electricity, at Englewood High School." The first year's work is preparatory for the second and covers Mechanics, Heat and Electricity as given in Mann and Twiss Physics, together with some practical constructional work in wiring and blue print reading. About 45 experiments are performed in the laboratory. Three single and two double periods per week are given to the work throughout the year. The second year combines theory and much more practice, construction, and electrical testing. Two periods per day are given throughout the year. Jackson and Jackson is the text used. The course is evidently successful as the enrollment is growing and very few drop out. The paper with accompanying drawings will appear soon in SCHOOL SCIENCE AND MATHEMATICS. Further information can be obtained by addressing Secretary Board of Education, Chicago, relative to the "Two Year Vocational Course in Electricity."

The concluding paper of the section was given by Prof. C. D. Poore, Northern Normal and Industrial School, Aberdeen, N. Dak., entitled: "Mental Economy in Physical Science" (Illustrated). Prof. Poore explained the development of a chart from which, by a series of grouped symbols representing all the various related scientific and mathematical quantities in common use, it was possible to make any required computations without formulae and much quicker by means of logarithms and the slide rule. The chart is certainly an ingenious device worthy of a more thorough study especially by those having much computing to do. The section then adjourned. CHAS H. SLATER, *Secretary pro tem.*

REGARDING BIOLOGY AS THE PUPIL SEES IT.

Mr. Wood in his article on "Biology from the Pupil's Standpoint" (December, 1913, Issue) expresses great surprise at the fact that the pupils did not answer topic C in his questionnaire in accordance with their views as shown in the charts. He considers the two results as contradictory and gives two reasons for the contradiction. Might it not rather be that he has not interpreted the results of topic C correctly?

In his results there is really no contradiction to be explained away. It is very possible, indeed probable, that pupils should prefer function subjects to structure ones and yet in *order of study* prefer to study structure subjects *first*. Pupils know from experience that they are able to understand the function of an organ better after knowing its structure, and their greater interest in function is more fully satisfied when the necessary structural details have first been studied. I think Mr. Wood would generally find that pupils who have a great interest in function, tolerate structure only as it leads to function, and hence realize that it is better to study structure first although they may not like it so well. Pupils also like to have the hard dry part of a subject over with as soon as possible, which is an additional reason why they like to study structure first in order of time. Had they voted to study function first, then would have been the real contradiction. ORAN L. RABER, Rushville, Ind.

INTERNATIONAL COMMISSION.

The definitive program for the meeting of the International Commission on the Teaching of Mathematics to be held at Paris in April, 1914, has been announced as follows:

WEDNESDAY, APRIL 1ST.

2:30 P. M. Session of the Central Committee.
4:00 P. M. Business Session of the Commission.
8:45 P. M. Session of the Mathematical Society of France.

THURSDAY, APRIL 2ND.

9:30 A. M. General opening session. President, L. Poincaré, Director of Secondary Instruction, representing the Minister of Public Instruction. Address of welcome by P. Appell, Dean of the Faculty of Science, Member of the Institute. Response by the President of the Commission, F. Klein, of Gottingen. Address by the representative of the Minister of Public Instruction. Lecture by E. Borel on "The Adaptation of Instruction to the Progress of Science." Lecture by M. d'Ocagne on "The Role of Mathematics in the Engineering Sciences."

2.30 P. M. Working session, taking up question A: "The Introduction of the Elementary Notions of the Differential and Integral Calculus into Secondary Instruction." General Reporter, E. Beke of Budapest.

FRIDAY, APRIL 3RD.

9:30 A. M. Working session, taking up question B: "The Mathematical Instruction of Engineering Students." General Reporter, P. Staeckel, of Heidelberg.

2:30 P. M. Working session. Discussion on the teaching of mathematics in engineering schools.

9:00 P. M. Meeting of the Society of Civil Engineeers (Rue Blanche).

SATURDAY, APRIL 4TH.

9:30 A. M. Working session. Conclusion of the discussion of questions A and B. Summaries by the General Reporters.

2:30 P. M. Business session. Consideration of the future work of the Commission, in particular of the program for the meeting of the Commission to be held at Munich in 1915, whose principal topic has already been fixed as "The Theoretic and Practical Preparation of Instructors of Mathematics for the Various Stages of Work."

9:30 P. M. Reception by Prince Bonaparte (Avenue d'Iena).

The sessions will be held at the Sorbonne except as otherwise specified. The general opening session will be public. Admission to the working sessions will be limited to members of the Commission and of the various National Subcommissions and Committees, and to such other persons as shall have been furnished with tickets of admission by the General Secretary.

The Philosophical Society of France, in conjunction with the publishers of the Encyclopedia of the Mathematical Sciences, invites the mathematicians present in Paris on the occasion of this Congress to a series of sessions to be held April 6th-8th, at which various questions of the Philosophy of Mathematics will be considered.

The Physical Society of France will hold its annual session and exposition of recent apparatus at Paris, April 15th-17th.

Mr. C. Bourlet, who died last August, has been succeeded in the Commission by C. Bioche, and Messrs. A. de Saint Germain and C. A. Laisant, who have resigned from the Commission for reasons of health and age, have been replaced by J. Hadamard and M. d'Ocagne.

A COURSE IN GENERAL SCIENCE FOR HIGH SCHOOLS, TO BE USED AS AN INTRODUCTION TO AGRICULTURE, DOMESTIC SCIENCE AND OTHER SCIENCE COURSES.

This course was adopted by the Agricultural Section of the High School Conference which met at the University of Illinois, November 20th-22nd. It was presented by W. L. Eikenberry of the University of Chicago High School, who has used the course for four years. A. C. Norris, Rockford, Illinois, and A. W. Nolan, Urbana, were Chairmen and Secretary of the section. These gentlemen would be glad to receive comments on the course from all interested.

Part I. The Air and Our Relation to It.

I. *Some physical characteristics of the air.*

A consideration of the more obvious physical properties of air, such as weight, pressure, compressibility, expansion by heating.

II. *Temperature changes and the seasons.*

Relation of changes in air temperature to length of daylight and inclination of sun's rays. Human interests in seasons.

III. *The water of the air.*

Humidity of atmosphere, humidity in homes, schools and out-of-doors, condensation of water, dew clouds, rain, etc.

IV. *Weather.*

Weather of temperate zone, weather maps, weather bureau, interpretation of atmospheric phenomena.

V. *Composition of air.*

Questions arising in the preceding chapter lead up to consideration of the molecular theory in simple form.

VI. *Composition of air.*

A simple discussion of the fundamental ideas of chemical action. Based upon a laboratory study of combustion.

VII. *Relation of the air to chlorophyll work.*

The origin of carbohydrates and the relation of the process to the atmosphere. Fundamental importance to all living things.

VIII. *Dust, molds and bacteria of the air.*

Starting from the dust constituents of the air, some consideration of bacteria and their relation to decay, disease, agriculture and industry. Culture method used principally.

IX. *Flying insects as distributors of bacteria.*

Considers the house fly principally, but notions received are applied to general problems of relation of insects to disease.

Part II. Water and Its Uses.

X. *Ice, water and steam.*

A discussion and laboratory study of the three states of matter; their practical applications.

XI. *Water pressures, buoyancy and density.*

Laboratory study of the topics; discussions of their applications.

XII. *Climatic influences.*

The specific case of the influence of the Great Lakes upon climate in the surrounding area, using data from Lake Michigan. The principles developed are related to the larger problem of oceanic influences.

XIII. *Commercial relations.*

The commercial importance of great bodies of water and the control of human activities thereby.

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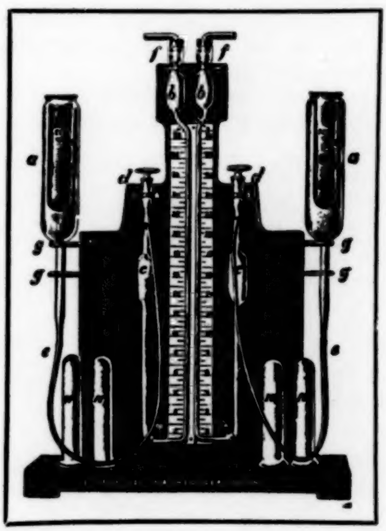

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XIV. *Water supply and sewage disposal.*

These problems are related to the preceding studies of water and of bacteria, and their importance in both city and country is developed.

PART III. WORK AND ENERGY.

XV. *Work by running water.*

Ideas of work, both mechanical and physiographic, are developed by reference to the work of running water.

XVI. *Work and machines.*

An introduction to the ideas of work through the agency of a simple machine—the pulley—and other machines.

XVII. *Energy and its transformation.*

Proceeds from ideas of work to those of energy, and the transformation of mechanical energy into heat.

XVIII. *The sun as a source of energy.*

The sun is considered as an immediate source of energy for certain purposes, as photosynthesis, and as the ultimate source of energy.

XIX. *Energy for plants and animals.*

Respiration, considered as an energy-giving process.

PART IV. THE EARTH'S CRUST.

XX. *Effect of natural forces upon the earth's crust.*

Introductory.

XXI. *Structure and composition of the soil.*

Sand, gravel, clay and humus as constituents of the soil.

XXII. *Origin of the soil.*

Includes weathering, glaciation, etc.

XXIII. *Soil water, drainage and irrigation.*

Considered in relation to agriculture.

XXIV. *Erosion and sedimentation.*

Their effect upon soils.

XXV. *Life in the soil.*

PART V. LIFE ON THE EARTH.

XXVI. *The plant covering of the earth.*

The natural vegetation of the earth and its importance to men.

XXVII. *Absorption from the soil by plants.*

The method and structures of absorption, and the materials absorbed.

XXVIII. *The world's food supply.*

Consideration of the manufacture of food in the plant, the importance of this manufacture to man, and the great industries founded upon it.

XXIX. *Utilization of food in the plant.*

Digestion, transference, storage, and assimilation.

XXX. *The nutrition of animals.*

The ideas of digestion, assimilation, etc., from preceding chapter are applied to the more complicated problem of animal and human nutrition.

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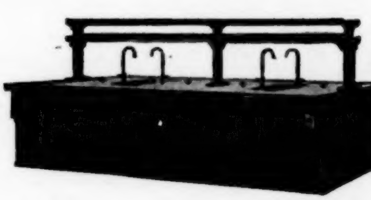

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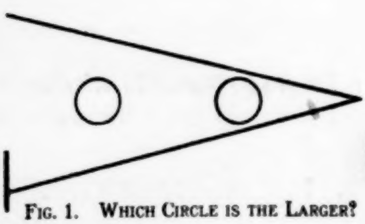

FIG. 1. WHICH CIRCLE IS THE LARGER?

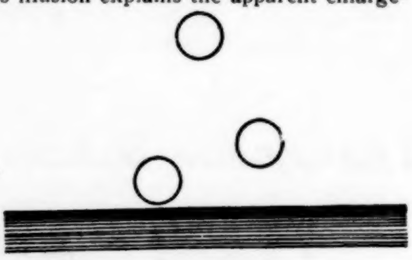

FIGURE 2.

A curious feature of the illusion in Figure 1 is that, if, according to the present writer's experiments, one covers up one of the lines of the angle with a white strip of paper, the illusion still persists, but if one shows a new figure with one line or with a number of parallel lines on one side of the circles, as in Figure 2, there is no illusion. The circles appear equal. —*Popular Astronomy*.

BOOKS RECEIVED.

Longmans' Technical Handicraft Series, Mechanics for Builders, Part I, by Edward L. Bates, School of Building, London, and Frederick Charlesworth, South-western Polytechnic Institute, London. Pages vi+201. Many diagrams. 12.5x19 cm. Cloth. 1913. Longmans, Green and Co., New York City.

A Text-Book on the Teaching of Arithmetic, by Alva W. Stamper, State Normal School, Chico, Cal. 284 pages. 13x19 cm. Cloth. 1913. American Book Company, Chicago.

The Examination of School Children. By William H. Pyle, University of Missouri. Pages v+67. 12.5x19 cm. Cloth. 1913. 50 cents. The Macmillan Company, New York City.

Cleveland Public Schools, Seventy-sixth Report of the Superintendent of Schools. Pages xi+107. 15.5x23 cm. Paper. 1912. Board of Education, Cleveland.

Industrial Chemistry for Engineering Students, by Henry K. Benson, University of Washington. Pages xiv+431. 13x19.5 cm. Cloth. 1913. $1.90. The Macmillan Company, New York City.

Lehrbuch der Geologie und Mineralogie für Höhere Schulen, grosse ausgabe. Von Prof. Dr. Paul Wagner. Pages viii+221. Mit 316 abbildungen und 4 Tofeln. 16x23 cm. Leinwand. 1913. M. 2.80. B. G. Teubner in Leipzig.

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Lehrbuch der Geologie und Mineralogie für Höhere Schulen, kleine ausgabe. Von Prof. Dr. Paul Wagner. Pages viii+221. Mit 316 abbildungen und 3 farbentafeln. 16x23 cm. Leinwand. 1913. M. 2.40. B. G. Teubner in Leipzig.

Veränderliche und Funktion. Von Mositz Pasch. Pages vi+183. 14.5x22.5 cm. Papier. 1913. Geh. 6. Geb. F. B. G. Teubner in Leipzig.

Eau oxygénée et ozone—Mémoires de Thénard—Schoenbein—de Marignac Soret—Troost—Hautefeuille—Chappius. 111 pp. Librairie Armand Colin, 103 Boulevard Saint-Michel, Paris. 1 fr. 30 (.26).

Mesure de la ritesse de la lumière. Etude optique des surfaces. Mémoires de Léon Foucault. 123 pp. 1 fr. 20 (.24).

Hygiene for Girls, by Florence H. Richards, William Penn High School. Philadelphia. Pages xi+242. 5x7.5 cm. Cloth. 1913. D. C. Heath and Company, New York.

The Lost Secret of the Even Balance, by John N. Lyle, Bentonville, Arkansas. 27 pages. 13x19 cm. Paper. 25 cents.

BOOK REVIEWS.

New Standard Dictionary, by Isaac K. Funk, Editor-in-chief, assisted by scores of specialists. Over 3,000 pages. Over 7,000 illustrations. Complete in all details. Absolutely new from cover to cover. 24x30x14 cm. Full morocco. 1913. $30.00. Funk and Wagnalls Company, 354-60 Fourth Ave., New York City.

To adequately express the writer's appreciation of this splendid volume would require several pages of this JOURNAL. It is not intended, therefore, to give an extended account of the many excellent features which it possesses. They all speak for themselves. It is absolutely a new creation from cover to cover. It is a dictionary in every sense in which this word is used, a book in which the etymology, pronunciation, spelling and meaning of practically every live word in the English language is given; a book which will give the information after which one is seeking. Every teacher and professional person, engineer, library, school and home should own a copy. We have no words except those of commendation to give to it. Mechanically, in every phase of the book maker's art, it is one of the best constructed books we have ever seen. C. H. S.

Elementary General Science, Book I, by Percy E. Rowell, Berkeley, Cal. Pages xvi+198. 13x19 cm. Cloth. 1913. 60 cents. The A-to-Zed School, Berkeley, Cal.

This book recognizes and emphasizes the fact that general science must rest upon a knowledge of those ideas with which the child almost daily comes in contact. It advocates teaching him all phases of general science, if this can be done according to the child's way of thinking. That which interests the child, the most, is that which has to do with his immediate environment. Throughout the book, this idea is kept in mind. No elaborate or expensive apparatus is advocated and indeed none is used. The cost of equipping a laboratory in which all of the seventy-nine experiments can be performed is reduced to a minimum. Many of them can be performed by the child at home. No attempt has been made to specialize any one phase of the work touched upon. There is, however, throughout the book a correlation from one part or subject to the next, the work of yesterday being used in that of today.

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